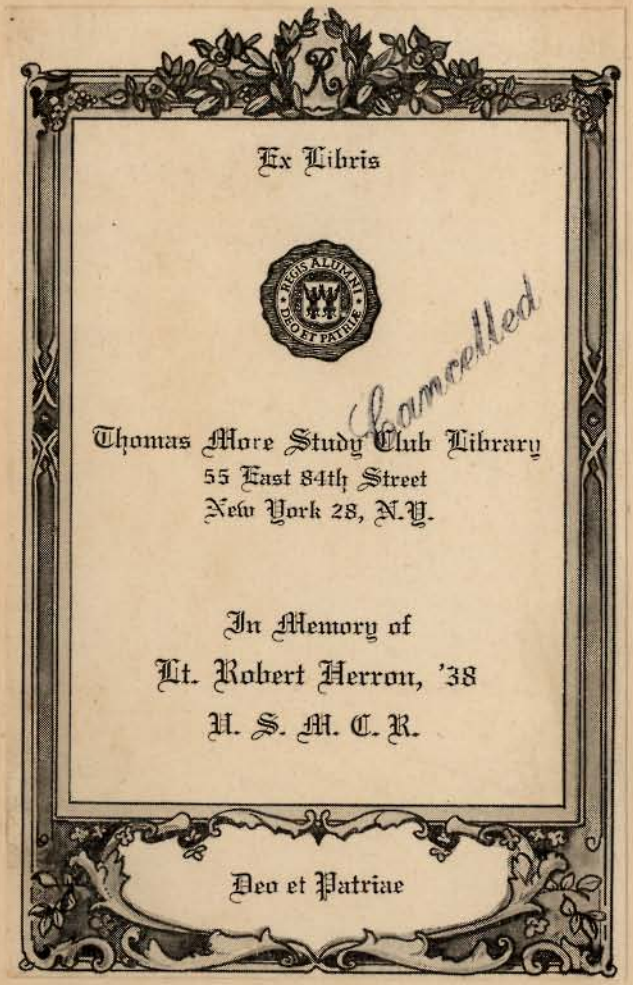


KEPLER AND THE JESUITS

BY M.W. BURKE-GAFFNEY

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"My thoughts are with the Dead; with them
I live in long-past years,
Their virtues love, their faults condemn,
Partake their hopes and fears,
And from their lessons seek and find
Instruction with a humble mind."

— SOUTHEY.

Kepler and the Jesuits

M. W. BURKE–GAFFNEY, S.J.

"I measured the skies."
JOHANN KEPLER

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CHAPTER I

INTRODUCING KEPLER

Johann Kepler was enjoying a studentship at the University of Tübingen when the *Paradies,* the Lutheran school at Graz, applied for a teacher of astronomy. Kepler was recommended and elected on the score of his mathematical ability. As he tells us, he had no particular taste for astronomy; but he had little choice. His patrons had recommended him; his penniless father had already deserted a querulous wife, and left creditors behind – beggars cannot choose.

At Graz Kepler had not only to lecture in astronomy, but had also to construct an almanac for each year, foretelling future events. He threw himself into the study of astrology, studying it with all the more zest when private prognosticating proved a lucrative practice. To gain experience and guidance, he noted the positions of the planets against the events of his own life, and those of his relatives – to these records we are indebted for the minutiae of his biography. He himself enters the picture at the instant of his birth, of which he gives us the time to the nearest minute: half-past one in the morning of December 27, 1571, at Weil, in Wurttemberg – a premature and sickly son, as, he says, the planets had foretold.

He was born in the best-known house in Weil, the residence of the Burgomaster, his paternal grandfather. It was only after Johann's birth that his parents set up house for themselves. The venture was not very successful; they fought like cat and dog. In 1574 Herr Kepler deserted his wife and two sons, to go and fight in Belgium. When Frau Kepler learned where he was, she went to the front herself and fetched him back. They bought a little farm in the village of Leonberg; but after he had been to war, there was no keeping Heinrich Kepler on

the farm. In 1576 he was off to Belgium again. This time he got a little more than he had bargained for. On November 4, 1576, Spanish fury was let loose in Antwerp; the town was sacked; the German mercenaries, under Count Oberstein, were completely routed and dispersed; and Kepler's father was home again. This time he bought a tavern in the village of Elmendigen, and Johann started to school. He went to a school where German was the medium of instruction, and not Latin, as at the next schools he was to attend. He recalls having heard much talk of the comet of this year, 1577, and of having been brought up to a high place by his mother to see it. The comet of 1577 was the one which Tycho Brahe proved to be more distant than the moon. By comparing observations made of it from Uraniburg and from Prague (which are about 400 miles apart), Brahe showed that it seemed to occupy the same position among the stars from wherever seen. The background of the moon, on the other hand, varies with the point of view. Eleven years later, Brahe published his facts which exploded the notion that comets were sublunary phenomena.

After three years at the school at Elmendigen, Kepler had to stay at home to help his parents. He worked in the fields at the tender age of nine, and never forgot how hard it was. One day he was called to look at an eclipse of the sun, and was struck by the redness around the moon as it blotted out the sunlight. It must have been, he later calculated, the eclipse of January 31, 1580.

Three years later his father lost all he possessed by a forfeited security; and Johann was free to return to school. Moreover, as the son of a pauper he was a deserving object of charity. The Monastery School at Adelberg opened its doors to him on October 16, 1584. After two years he was received into the Protestant Seminary of Maulbroon. There, in 1589, he passed a brilliant bachelor's examination, and was sent to the University of Tübingen to master in philosophy. As part of the usual course, Kepler had to study astronomy. Though interested, he did not then suspect that astronomy was to be his life's work. His professor of astronomy was Michael Mästlin;

and his textbook was the second edition of Mästlin's *Epitome of Astronomy*. Mästlin's book made no mention of Copernicus or his theory. But Kepler tells us that Mästlin explained the Copernican theory to him, and that he himself admired it. His admiration sowed a seed which was to be the source of much fruit after he left Tübingen. However, he did not leave immediately after receiving his master's degree; but was kept on, carried by funds supplied from the foundation of the University. He was waiting and hoping to be promoted to Wittenberg, to proceed to his doctorate in theology. Meanwhile, he wrote a paper on the motion of the earth, and how it might be reconciled with Sacred Scripture. Then, in 1594, Graz, in the Province of Styria, applied to Tübingen for a scholar capable of teaching astronomy. The Senate of Tübingen suggested Kepler; the Rector advised him to accept.

Graz is pretty. It is on the banks of the Mur (the Napoleonic French called it *la ville des Graces sur la rivière de l'Amour*). Lutheran doctrine found its way to Graz as early as 1530, and in 1540, a Lutheran school, the *Paradies*, was opened. The Archduke Charles recognized the teacher of astronomy at the *Paradies* as Provincial Mathematician. When Kepler went to Graz, there was no Archduke in residence. Charles had died in 1590, when his eldest son and heir, Ferdinand, was twelve years of age. The young Archduke did not take over the government of Styria until 1596. Until he took over, Kepler's Lutheranism was no impediment to his being Provincial Mathematician in a Catholic province.

Kepler went down to Graz all but convinced of the truth of the Copernican theory. The only difficulties he had in admitting it were other than mathematical. He could understand the earth being the center of the universe, as Ptolemy would have it. All things were created for men who live on the earth. Why then should the sun be the center of our system? He thought up this answer for himself:

> Of all the bodies in the universe the most excellent is the sun, whose whole essence is nothing else but the purest light. Than it there is no greater star; singly and alone it is the

> producer, conserver, and warmer of all things. It is a fountain of light, rich in fruitful heat, most fair, limpid, and pure to the sight. It is the source of vision and the portrayer of all colours, though itself devoid of colour.

There remained other difficulties. Why were there five planets besides the earth? Why not more or less? And why had the all-wise Creator placed them as He did? For their distances from the sun, as given by Copernicus, there seemed to be neither rhyme nor reason. Taking the distance of Mercury as unity, their mean distances were proportioned as follows:

Mercury	1.00
Venus	1.87
Earth	2.58
Mars	3.94
Jupiter	13.45
Saturn	24.75

Why weren't their distances in simple proportions, as 1, 2, 3, 4, 5, 6? There must be some reason. Kepler searched his geometric mind, and finally found what be believed to be the true solution. He carefully noted the date of the discovery, July 19, 1595, a date which he expected would go down in history. He explained:

> God, in creating the universe and regulating the order of the cosmos, had in view the five regular bodies of geometry as known since the days of Pythagoras and Plato.

These five regular solids are, of course, the cube, tetrahedron, dodecahedron, icosahedron, and octahedron. According to Kepler's "discovery," Saturn's circle was a great circle of a sphere; in this sphere was inscribed a cube in which was inscribed a sphere, a great circle of which was the circle of Jupiter. In Jupiter's sphere was inscribed a tetrahedron in which was inscribed a sphere, a great circle of which was the circle of Mars. In Mars's sphere was inscribed a dodecahedron in which was inscribed a sphere, a great circle of which was the circle of the Earth. In the Earth's sphere was inscribed an icosahedron in which was inscribed a sphere, a great circle of which was the circle of Venus. In Venus' sphere was an octahedron in which was inscribed a sphere, a great circle of which was the circle of Mercury. Near the center of Mercury's sphere was the immobile sun. Since, according to Copernicus, the planets circled about a point on their circles, it was necessary to give each sphere a thickness, to afford room for the planet's peregrinations. A model of the solar system designed according to Kepler's plan would be very close to a true-to-scale model. Its slight deviations from the proportions of Copernicus' system, Kepler attributed to errors in observations which Copernicus used for his calculations.

It was to Mästlin that Kepler broke the news of his discovery, and wrote of his desire to publish. Mästlin was very much pleased with his former pupil's effort, but it was with mixed feelings that the Senate of Tübingen received his application to put their blessing on the book. The Senators insisted that attempts to reconcile the words of Scripture with a moving earth be omitted. Furthermore, they suggested that since readers of the book would not be as conversant as Kepler with the text of Copernicus, elucidations would be in order. In a word, Kepler went through all the tribulations of an author, and his work was not off the press until December, 1596. Its very title, *The Precursor of Mathematical Dissertations Containing the Cosmographic Mystery About the Wonderful Proportion of the Heavenly Orbs,* indicated that it was but a beginning.

Mästlin, in editing *The Cosmographic Mystery* and seeing it through the press at Tübingen, bore the brunt of the publishing worries, and at no little inconvenience. Indeed, in his own words, it was "at very great inconvenience." He grumbled to Kepler in March, 1597: "I was not able to finish my writing against the New Calendar in time for the market, and as a consequence was severely reprimanded by the Senate." The New Calendar was the one question on which Kepler and Mästlin did not see eye to eye. Kepler was now no longer a pupil but an author; his chest was inflated. Taking his pen in hand, he told Mästlin what he thought of the futility of kicking against the goad. Kepler taught not only mathematics and astronomy but also history. He was interested in history, and talked, this very

year, of devoting his life to history. History told him the story of the New Calendar, and he took a very sensible view of it.

Astronomers advised Julius Caesar that the length of the year of the seasons was 365¼ days. By the length of the year of the seasons is meant the time from the beginning of one first day of spring to the beginning of the next first day of spring. The first day of spring begins when the sun crosses the celestial equator in the northerly direction. In order to have the same month in the same season each year, Caesar decreed that, starting with January 1, 46 B.C., the calendar year would have 365 days, except once in four, when the year would have one day more. The Julian calendar, as Caesar's calendar was called, remained the calendar of Europe until 1582. Meanwhile, much water had passed beneath the bridges.

Caesar had been misinformed. The length of the year of the seasons is not exactly 365¼ days, but some minutes short. This was known to the Fathers of the Council of Nicea (325) when they laid down the rules for determining the date of Easter from the date of the first day of spring. St. Gregory of Tours (544–595) observed that the first day of spring was coming earlier and earlier at the rate of one day in 128 years. About the year 750, the Venerable Bede remarked that the first day of spring was March 18, three days earlier than at the time of the Council of Nicea. He was somewhat concerned, for Easter was slowly but surely backing up toward January. In the thirteenth century the question got much attention. John Holywood (Sacrobosco) made first approximations of the error in the accepted length of the year of the seasons, and determined it to be by 11 minutes and 14 seconds short of 365¼ days. Roger Bacon wrote a paper, *On The Reformation of The Calendar,* which was transmitted to the Pope. Outstanding in the fourteenth century were the astronomical conference held by Clement VI at the papal court of Avignon, and the letter published by two of its members on the question of the reform of the calendar. In the fifteenth century the question was taken before Church Councils. The advocates of reform were men whose names are well known in the history of astronomy. Cardinal Pierre d'Ailly

suggested to the Council of Constance (1414–1418) that one leap year be omitted every 134 years. At the Council of Basle (1431) Cardinal Nicholas de Cusa endorsed d'Ailly's suggestion, and, in addition, proposed that the date of the first day of spring be brought back to the third week of March by passing in 1439 from May 24 to June 1. His *Restoration of the Calendar* was an inspiration to subsequent reformers.

Early in the sixteenth century there was action. Leo X wrote to Maximilian I, the princes, bishops, and universities to obtain their opinions on the calendar, and appointed Paul of Middleburg president of a commission for its reform. Maximilian charged the universities of Vienna, Tübingen, and Louvain to express their opinions. Their opinions, together with a treatise by Paul of Middleburg, were laid before the Fifth Lateran Council (1512–1517). Copernicus was then asked to submit his views. He favored waiting until the motions of the sun and moon were better understood, so that the reform would be definitive. His voice carried the day, and amendment of the calendar was deferred. Against Copernicus were those who voted for an immediate, even if temporary, betterment of the calendar, on the grounds that already the first day of spring was falling on March 11, and hence it was possible to have Septuagesima Sunday two days after Epiphany, and Easter on March 12.

Protestants and Catholics were agreed on the necessity for reforming the calendar; but, as to how it should be reformed, there were nearly as many views as there were men. The Council of Trent, in its last session, left the reform of the breviary, missal, and calendar to the Pope. Pope Pius V published the revised breviary, and his successor, Gregory XIII, appointed a commission for the reform of the calendar. Through Antonio Giglio the commission was presented with a manuscript left by his recently deceased brother Luigi – better known to posterity as Aloysius Lilius. Lilius' scheme for the reformation of the calendar became the basis of the Gregorian reform. An account of the proposals made by Lilius was sent to all princes, universities, and scholars, and their opinions were invited. Replies

came in plenty; their diversity dumbfounded the commission. The Pope instructed it to go ahead with one definite plan, whichever its members agreed upon to be the best. Since the members of the commission were by no means agreed among themselves, they appointed a subcommittee of one, the Jesuit Father Christopher Clavius. He drew up a simplification of Lilius' scheme. Lilius had sized up the problem by pointing out that there were roughly three calendar days too many in each 400 years, and suggesting that three leap years every 400 years be dropped. Father Clavius specified that the last year of a century should not be a leap year unless the year be divisible by 400, for instance, the years 1600 and 2000. He fully realized that this left an error, an error amounting to one day in 3333 years, but it was near enough for the present. The commission agreed that the first day of spring should be restored to March 21. Accordingly Pope Gregory's Bull, *Inter Gravissimas,* decreed that October 4, 1582, should be followed by October 15, and that thereafter leap years should be dropped at the end of centuries, except when the last year of the century was divisible by 400.

Pope Gregory's successor, Sixtus V, wrote that if the Jesuits had done no other thing in the wide world worthy of merit, they must be at least praised for this: their schools had produced a Clavius. So thought the Pope; not so the Lutherans. Those who rushed into print against the new calendar were without number. Foremost among the belittlers of Clavius was Mästlin. By 1593 he had published his fourth diatribe. The first had gained for him his professorship at Tübingen; the second was a reply to Father Buys (Busaeus); the third, a defense against Father Possevino; the fourth, an answer to Father Clavius' attack on him. He was engaged on the fifth, a criticism of Clavius' *Explanation of the Roman Calendar,* when interrupted by the editing of Kepler's book. Kepler wrote to him:

> I know, of course, that what you are undertaking to defend is backed by proofs which neither *Clavi* nor *Clavate* devices, nor, indeed, the whole machinery of heaven, could shake. . . . But while I hold all this, I am for the rest largely heretical. What is half Germany doing (I ask)? How long does it mean to hold aloof from the rest of Europe? For what are we waiting? . . . It is 150 years since astronomers demanded legislation for some correction, and Luther himself demanded it. . . . Now one correction has been made; no one can easily introduce another into a small part of Europe without great disturbance. Therefore, either the old form must be retained or the Gregorian accepted. But which? . . . The States have proved their independence of the Pope for almost twenty years: let that suffice. He already sees that we may, if we wish, retain the old calendar. If we choose to emend it in the same way as he did, it is not because we are forced to do so, but because it seems good to us to do so. . . . It is a disgrace to Germany that they who discovered the art of reformation should alone remain unreformed.

This perky letter was written to the tune of wedding bells. Kepler had wooed and won a prospective bride. Barbara Müller was, admittedly, all the more desirable because wealthy, and, seemingly, none the less because a divorcee. At the age of twenty-three Barbara was the mother of a six-year-old daughter, had buried one husband, divorced another, and was willing to try a third. Her people were not so sure of this Kepler, and before they would countenance the marriage, he had to betake himself to his native country and search out documentary evidence that he was not of common stock. His journey was not in vain. Now all was bright and beautiful. In April, 1597, Johann and Barbara were married. To add to their joy, *The Cosmographic Mystery* was now in circulation, and winning notice for its author.

Kepler deemed it might serve to introduce him to the scientists of the world. He sent a copy to the Professor of Mathematics at the University of Padua, Galileo Galilei, seven years his senior. Galileo received it and acknowledged it the same day, August 4, 1597. He wrote with enthusiasm that he had the book only a few hours, but had read the preface and was delighted to find an associate in the search of truth, and a friend of truth itself. By truth he meant Copernicanism, for he continued:

> Many years ago I became a convert to the opinions of Copernicus, and by that theory have succeeded in explaining many phenomena which are inexplicable with the common hypothesis. I have drawn up many reasons for it, and refutations of the opposite, which I have not dared to publish, lest I should meet with the same fate as our master, Copernicus, who, although he has earned immortal fame for himself among many, is with an infinite number (so great is the number of fools) considered fit only for raillery and derision.

Kepler was pleased with what he considered a promised friendship and replied saying so. He also wrote:

> It is not only in your Italy that there are those who will not believe the motion of the earth unless they can feel it; also here in Germany that doctrine is not too well received.

Galileo never acknowledged this letter, nor did Kepler presume to write him again for 13 years.

Before coming to Graz, Kepler had lived a hothouse life; he had not moved in circles outside his own. He had no personal knowledge of Jesuits. The word *Jesuits* does not occur in any of his writings prior to 1596; it is then found in his unpublished commentary on Schleiden's book *On The Four Monarchies.* In passing, Kepler mentions how events too startling may excite fear or love beyond all control; as an example, and not a very good one, he instances the Japanese princes "whom the Jesuits brought to Rome." – His reference is to an embassy of Catholic Japanese princes who came to Rome in 1585. It is true that their coming was engineered by a Jesuit, and that they were much impressed by all they saw. It is equally true that Lutherans were chagrined, and that they had recourse to print to discredit the venture, and to lament that the Japenese had not come to Germany. Kepler's remarks were a reflection of what he had read.

In September, 1597, a Jesuit, Father Christopher Grienberger, came from Munich to the University of Graz as professor of mathematics. He brought Kepler a letter from Herwart von Hohenburg, Chancellor of Bavaria. Herwart had read Kepler's *Cosmographic Mystery,* and thought the author was a

man who might be able to help him. He wanted to know to what year a description of the heavens given by Lucan in his *Pharsalia* could apply. Kepler attacked the problem with zest; his lengthy analysis finally favored the year 51 B.C. In sending his answer to Herwart, he wrote bluntly that he acceded to the request, not because he thought no one was more fitted than himself for the task, "but because of the occasion offered of meriting of so great a man." His hopes of meriting were not in vain. A close friendship sprang up between the two scholars, and their correspondence became constant. Kepler "merited" immediately; as early as October, 1597, Herwart commended him to Casal, private secretary to Archduke Ferdinand, and to John Menhard, registrar at the Imperial Palace at Prague. Father Grienberger dropped from the picture completely.

Being noticed by Herwart encouraged Kepler. In December, 1597, he ventured to send his *Cosmographic Mystery* to Tycho Brahe. Brahe, the leading astronomer of the day, had won fame by his accurate observations of the nova, or new star, of 1572. For the glory he brought to his country, Denmark, he was rewarded by its king, Frederick II, with the island of Hveen, a magnificent observatory, which he called Uraniburg, and the best instruments an astronomer had ever had. There he worked for 21 years, accumulating observations and becoming proud and arrogant. King Frederick was tolerant; not so his successor Christian IV. Brahe's continual quarrels with tenants of the island, undue extravagance, and disagreements with the King resulted in a withdrawal of his fief.

In June, 1597, Brahe abandoned Hveen, and sailed for Rostock. It was six months later that Kepler sent a copy of his work to Brahe, with a polite covering note. He admitted that he had never seen any of Brahe's publications. "Whatever I know of you," he wrote, "I learned from Mästlin." – Unfortunately, he had not learned enough. In 1588 Brahe had printed a book in which he proposed a *via media* between the Copernican system and the Ptolemaic. His system, known to this day as the Tychonic, supposed the planets to circle the sun, which traveled around the stationary earth. Nicholas Reymers put out, the very

same year, a book in which he expounded a similar system. Kepler had heard of Reymers' book, but not of Brahe's, and in writing to Brahe he sang Reymers' praises. This was a *faux pas*. Brahe was far from being as enthusiastic about Kepler's work as was Galileo; yet, the sending of the book opened the way for an acquaintanceship which was to have its effect on Kepler's life, and on the whole history of astronomy. Writing from Wandsbeck observatory, near Hamburg, Brahe thanked Kepler for the copy of *The Cosmographic Mystery,* and gave due praise to the ingenious speculations of its author. He had some doubt as to the value of the numerical data employed; and, of course, he regretted that the Copernican system was what Kepler sought to justify, and hoped that Kepler would yet discover some reason for favoring the Tychonic system. Above all, he resented Kepler's fulsome praise of Reymers, whom Brahe accused of plagiarism. Kepler had been ignorant of the Brahe-Reymer feud. His sincere reply and ample apology won the admiration of Brahe. This was fortunate, for Kepler was soon to need a friend.

The young Archduke Ferdinand had taken over the government of Styria in 1596, and was bent on extirpating heresy throughout his dominions. In September, 1598, he ordered all Protestant preachers and teachers to leave the country. Herwart's commendations stood Kepler in good stead; he was exempted from the decree. But he was not happy under the new regime; he had very few pupils, and there were some who grumbled at his being retained for what they considered a sinecure. He wrote to Mästlin that he would like to leave Graz. Could he get appointed to the staff at Tübingen? He could not. The future was looking barren to Kepler when his stanch friend Herwart wrote him that Brahe had gone to Prague, and had been appointed Imperial Mathematician. Herwart added: "I wish you had some such position; but who knows what fate has in store for you?" Kepler was no fatalist; he took action. He wrote to Baron Hoffman, a privy councilor at Prague; would he whisper a word in the Emperor's ear? A few months later Kepler had a letter from Brahe himself; now that they were

living not so far apart, said Brahe, he was looking forward to meeting Kepler sometime. And if Kepler would wish to work with him, he could rest assured that their difference of opinion on the Copernican question would be no difficulty.

In January, 1600, Kepler set out for Prague. He was not abandoning Graz; he wished to meet Brahe, and see how it would be to work with him, and then to obtain, if possible, an official appointment. Brahe was at his observatory, the Castle of Benatky, 2 miles northeast of Prague. When Kepler arrived there, the five planets were in the evening sky, but not as neatly aligned as in February, 1940, for Mars and Jupiter were in the southeastern sky while Mercury and Venus were in the southwestern. Brahe had two assistants, his son Jorgen, who looked after the laboratory, and Longomontanus, who worked on the theory of Mars's motion. Brahe received Kepler most cordially, and was kindness itself; but it was humiliating to Kepler to find that in Brahe's eyes he was just another young assistant – he had to start at the bottom of the ladder, as an amanuensis. He aspired to work on the question of the orbit of Mars; at length, Brahe consented, and Longomontanus concentrated on the orbit of the moon. A trip to Prague and an interview with the Imperial Chancellor obtained for him an official appointment as assistant to the Imperial Mathematician. He then set out for Graz to collect his wife and stepdaughter – he had had two children himself since he married, but they both died, one after a month, the other after two.

He arrived in Graz just in time to hear of another decree against the Protestants; all state officials were to choose between professing the Catholic faith or leaving the province within 45 days. Kepler chose to leave. When he arrived at Prague, he found that Longomontanus had returned to his native Denmark, and that the Emperor had approved the appointment of Kepler as chief assistant to Brahe. The future looked drab to Kepler; he had no desire to be an astronomer's assistant all his life. He wrote to Mästlin. Would the University of Tübingen receive him back on its foundation, this time to study medicine? Mästlin did not reply; he did not write to Kepler for five years.

Kepler had come out openly for Copernicanism and the new calendar; he had made his own bed, now he must lie in it. One thing Kepler would do; he would make amends to Brahe for his previous praise of Reymers, who was also known as Ursus. He set to work and wrote a lengthy booklet, entitled *Defence of Tycho Against Ursus*. He had it written, but not published, when Tycho took suddenly ill and died. He died on October 24, 1601, leaving to Kepler the priceless heritage of his observations. Kepler now had that for which Archimedes longed, something to stand on – and he moved the world.

CHAPTER II

THE IMPERIAL MATHEMATICIAN

Kepler was named successor to Brahe as Imperial Mathematician, but the Emperor, who had found Brahe worth 3000 florins a year, would offer Kepler only 500. Kepler readily accepted. The term mathematics had a wide range in those days, including all that was known of the sciences which we now call mathematics, physics, astronomy, and meteorology. Moreover, the Emperor Rudolph II expected his mathematician to be a good astrologer. Kepler's first step, therefore, was to publish a little book in which he explained how much and how little faith he put in astrology. He entitled it *On the More Certain Foundations of Astrology*. He declared that, as Court Astrologer, he would endeavor to glean the grain of truth which he believed the art of astrology to contain; and that he would limit his prognostications to the estimate of tendencies and probabilities. Already in 1598 he had essayed to explain how difficult it is for the astrologer to foretell the future character of people, because of prejudices which enter to sway their native bent. He asked his readers to consider Archbishop Bellarmine, who was not then a Cardinal, and continued:

> Bellarmine is one of the most learned of men, but he is shackled by cupidity and fear of disgrace. Alas, by how many obstacles is truth surrounded! Bellarmine, possibly, does not read, or does not ponder, the defences of our case.

With the astrological sop to the Emperor finished, Kepler was free to turn his attention to Brahe's papers. Tycho had been a most careful observer of the effect of the earth's atmosphere on astronomical observations. He noticed, as others had done, that the sun, moon, planets, and stars did not appear in the sky precisely where predicted. Whenever he made an observation,

he noted the difference between the apparent altitude of the body and the predicted altitude, and so built up a table of refractions. Kepler obtained from the Emperor permission to devote some time to an explanation of these observations. The result was a remarkable work entitled *A Supplement to Vitello, in Which the Optical Branch of Astronomy Is Explained.* Kepler usually referred to it as his *Optics* — so shall we. A supplement to Vitello, who was the author of a standard work on optics, it introduced the question of optics into astronomy.

That optics had any place in astronomy was not known by many before the invention of the telescope. Kepler discovered that a number of optical questions were involved. The first was the refraction of light, i.e., the change in direction of a ray of light as it passes from a medium of one density to a medium of another density in a direction not perpendicular to the surface of contact between the media. A ray of light coming from a star which is not directly overhead is refracted on entering the earth's atmosphere. When the ray reaches our eye, it is more nearly vertical than before it entered the atmosphere, and the star appears to us higher in the sky than it really is. Kepler showed that the amount of refraction is a function of the original ray's deviation from the vertical; thus, light entering the earth's atmosphere from a star is not refracted when the star is directly overhead, whereas it is refracted more and more as the star sets and comes closer and closer to the horizon.

In his *Optics* Kepler does much more than state his conclusions from Brahe's observations; he exposes his whole line of thought. Starting with a disquisition on the nature of vision, he is led to consider the shape of the natural lens with which our eyes are endowed, and then to discuss how light is refracted by lenses of different shapes. Before explaining how the atmosphere refracts light, he has to raise the question of the extent of the earth's atmosphere. He rejects the opinion that it extends all the way to the stars, for that it is limited in extent is essential to the explanation of the optical illusion of the displacement of the stars. From the optical illusion due to refraction by the earth's atmosphere, Kepler passes to the defects of our own eyes,

and gives the correct physiological explanation of shortsightedness and long-sightedness. He not only shows that myopia is due to the focus formed by the lens of our eye falling short of the retina, and long-sightedness due to its being formed too far back, but prescribes remedies: for shortsightedness, concave spectacles; for long-sightedness, convex. Being very shortsighted Kepler himself wore concave spectacles when observing the stars.

The eighth chapter of Kepler's *Optics* carries the title: "Of the Shadow of the Moon, and Daytime Darkness." It commences with an explanation of the occasion of the question. Father Clavius, says Kepler, reports in his *Commentary on the Sphere of John Holywood,* that at the time of the solar eclipse of 1560 (which Clavius observed from Coimbra) such darkness fell upon the earth that one could not see where to put one's feet, the bright stars shone forth, and the birds were silenced. Brahe found it difficult to believe this; for one thing, he had never witnessed such darkness at eclipse time; and furthermore, he reckoned that even when the moon was at its nearest to the earth, and the sun at its furthest, the moon would not block out all light from the earth by coming between us and the sun. Kepler, the historian, delved into history and brought forward numerous accounts of terrible darkness at times of solar eclipses. The weight of evidence was in favor of Clavius; therefore, Kepler believed him and sought an explanation. He suggested that no light could reach the earth by refraction unless the sun's rays reached the earth's atmosphere, and that if the earth's atmosphere was not of great height and the sun was at its furthest from us, no rays would reach the earth at the time of total eclipse.

The third question of the eighth chapter of the *Optics* was: "Is it possible that in a central conjunction of the sun and moon, the sun may not be entirely hidden?" He approached this question also through the avenues of history.

> Thus far we have proved from history that many times the whole sun has been hidden, even by the moon at its furthest. It is, therefore, the more remarkable that in all history there

> is but one example to the contrary, that which Clavius, in his *Commentary of Hollywood,* relates, saying: "In the year 1567, on April 9, at Rome, the sun was not entirely hidden, but there remained a thin circle of its light around the moon." Nevertheless, the moon was between its nearest and its furthest. It is remarkable, I say, for the visible diameter of the moon would be smaller, and this cannot be set down as an optical illusion. . . . Therefore, what Tycho Brahe did for one eclipse of Clavius, I do for the other, namely, call it in doubt. I question whether the circle was complete or, more likely, a thin crescent at one side, just before the centers of the sun and the moon were in line.

The nearest approach to the phenomenon which Clavius claimed to have seen, Kepler found described by Plutarch in his *On The Face of the Moon.* To say that Kepler was familiar with this treatise is no hyperbole; he translated it, entire, from Greek into Latin, and added notes. Plutarch testified to a brilliance surrounding the periphery of the moon while it blotted out the sun from sight. Kepler went to pains to point out that Plutarch did not claim to have seen the circumference of the sun, as did Clavius, for he said that the light was *around* the moon; he did not say *behind* it. Kepler had an explanation for Plutarch's observation. The sun illuminated the "air" around the moon; and he had evidence to confirm his theory.

> My opinion is confirmed by Herr Jessen, of whom I made mention in Chapter V. In the year 1598, on February 25 (or March 7), he watched the eclipse of the sun through clouds, and saw a brilliant light surrounding the moon. . . . But that eclipse, according to Brahe's calculations, could not have been total. . . . Jessen could not have seen the sun all around the moon, but what he saw all around the moon was the brilliance of air.

Johann Jessen's name crept into Kepler's *Optics* more by his being a close friend of Kepler at this period, than by his being a trustworthy witness. He had been physician to the Duke of Saxony and professor at Wittenberg, and an intimate friend of Tycho Brahe. He came to Prague as professor of medicine at the Academy. He was witness to the preliminary contract drawn up between Brahe and Kepler. When Brahe died, he preached

his funeral oration – and very laudatory it was. Kepler inherited the friendship Jessen had had for Brahe. But when Jessen was Rector of the Academy at Prague, and the Academy was known as leftist, Kepler, the Imperial Mathematician, wisely followed at a distance. In 1617, Kepler declined Jessen's invitation to occupy the chair of mathematics in the Academy. Four years later insurrection broke out in Prague; the Academy was branded as the seat of rebellion, and Jessen as the convener of traitors. He paid for his folly with his life.

Kepler finished his *Optics* on July 28, 1604. A few months later there was to be a sight in the sky which was causing great expectations among astrologers. Mars, Jupiter, and Saturn were to be gathered together in the sign of the Archer, which was one of the signs of the astrologers' "Fiery Trigon." As an omen, a convention of superior planets in the Fiery Trigon ranked high. Astronomers were also interested. Many were the eyes turned toward the sky. Kepler tells us why:

> Some watched to correct their ephemerides; some, for pleasure's sake; some, because of the rareness of the happening; some, to verify their predictions; and others, indeed, to see if there would be a comet, as had been expressly predicted by Arabian astrology.

The most spectacular stage of this great convention was reached about October 2, when the three planets were at the vertices of an equilateral triangle with its base, the line joining Saturn to Jupiter, horizontal. On September 26, Mars had passed below Saturn; on October 9, it was directly below Jupiter. On this latter date, the distance between Saturn and Jupiter looked like about nineteen times the width of the moon; and Mars seemed to be about four times the moon's diameter below Jupiter. October 10 was a Sunday. Johann Brunowsky, assistant to the Imperial Vice-Chancellor, spent this Sunday evening stargazing. As he stared at the planets, he was amazed to see a bright star, as bright as Jupiter, to the right of Jupiter and higher up – about six moons away from Jupiter. Brunowsky had never seen this star before; and he was familiar with the stars. As he watched with wonder, clouds came to

obliterate the view. In the morning he reported his news to Kepler. Kepler was agog. He counted the hours until evening would come again. He had to wait many evenings. Though Prague is inland, its weather is not unlike that of a seaboard town. Not until October 17 was there a cloudless sky over Prague. That day the sky was cloudless as darkness set in; Kepler was watching for the planets to appear; but before it was dark enough for them, the New Star shone forth. Kepler was thrilled as he looked at this, the brightest star in the heavens that night, a star which he had never seen before, and which generations of men had never seen. It was Sunday evening; the pious Kepler thought of the Magi of old. Had they too, like Brunowsky, been looking at the planets when the Star of Bethlehem shone forth? It seemed certain that astrologers were watching the skies in 7 B.C., when Jupiter passed Saturn three times, and when Saturn, Jupiter, and Mars were straddling the beginning of the first sign of the Fiery Trigon. No living authority known to Kepler placed the appearance of the Star of Bethlehem in 7 or 6 B.C. Joseph Scaliger, the leading chronologist of the Protestant world, worked out 3 B.C. as the year of the birth of Christ; Cardinal Baronius, among Catholics, also made out 3 B.C. to be the year of the Nativity. Kepler would read his Scaliger again.

Scaliger has been rated the greatest classical scholar whom France has produced; but the great work of his life was the creation of a scientific system of ancient chronology. He broached the subject of chronology in 1577 in his edition of Manilius, which was practically a treatise on ancient astronomy. He laid the foundation of his system with his *On the Correction of Dates,* which was printed at Paris in 1583, and which ran to a second edition at Leyden in 1598. Kepler had studied the first edition of this work at Tübingen; he now read the second edition. It irked him to find Scaliger still misunderstanding the Greek year, which began with the full moon next to the summer solstice. He summoned up courage to write to the French scholar, now living on a pedestal in Leyden. His letter, written about the month of May, 1605, commenced:

> Many times have I had in mind, Joseph Scaliger, of illustrious birth and immortal fame in literature, to confer with you on matters pertaining to the measurement of time. . . . Now I set down the fruits of my thought, encouraged by your courtesy, and especially by the elegance and modesty displayed in your first book. . . . From all the authorities, whom you bring forth in both editions, it is, without doubt, apparent that the Attic year, which you reconstructed in your first book, was far from that form which you think it to have been.
>
> Of what form I believe it to have been, I shall first describe; then I shall throw in arguments, either confirming my opinion or refuting yours, and some conjectures. . . .

The remainder of the letter, which would occupy about twenty pages of this book, contained thirty-four numbered arguments. Johann Pistorius found them very interesting; he was one of the Emperor's councilors — the one with the portfolio of mathematics, or, as Kepler put it, "he has been appointed over me, by the Emperor, as one to whom I have to give an account of my time; by which it is understood that I may not conceal from him any of my professional works, whether private or public." About a month later, when he was setting out on his summer holidays, Pistorius took a copy of the letter with him. He was heading for the Netherlands. On the way he passed through Mainz, and stopped to pay his respects to the Archbishop-Elector. In the waiting room of the Archbishop's palace, he met a Jesuit, Father Nicholas Serarius, Professor of Sacred Scripture and Theology. The conversation came round to Scaliger. Father Serarius was putting the finishing touches to a book criticizing Scaliger's chronology. Pistorius told him of Kepler's letter, and sent a servant to fetch it from his saddlebag. As he was showing it to Father Serarius, the good father was informed that His Grace the Archbishop awaited him. Pistorius said he would leave the letter together with permission to publish it, if Father Serarius so wished.

Father Serarius did not wish to publish a letter by Kepler without Kepler's personal permission. Accordingly, he was pleased when, about a week later, an opportunity presented itself of sending a letter to Kepler. In this letter, the first which

Kepler received from a Jesuit, he told what had passed between him and Pistorius, and asked Kepler's permission to publish his letter to Scaliger. He further asked Kepler to reply "as soon as possible," and enclosed a note from his colleague, Father Ziegler, professor of mathematics. Father Ziegler wanted to know if one might look forward to the publication by Kepler of the Rudolphine Tables, commenced by Tycho Brahe.

When Serarius' letter arrived at Prague, Kepler was in Graz, seeing about some real estate inherited by his wife. In his absence, his secretary read all letters addressed to him and conveyed to him the gist of those calling for personal attention. It was thus that Kepler, at Graz, received a summary of Serarius' letter to him. Shorn of its urbanity, the letter seemed peremptory. Kepler was furious with Pistorius; but he instructed his secretary to reply to Father Serarius that if Pistorius had given permission, he could not refuse; but the publication of his letter to Scaliger would be very distasteful to him. To his secretary he protested that he did not know these Fathers:

> I seem to have seen Nicholas Serarius' name in booksellers catalogues many times; it is otherwise unknown to me. Who that Father J. Ziegler is, I cannot even guess from the name.

Kepler's absence in Graz was a cause of great delay. Two months elapsed between the time that Father Serarius wrote his letter to Kepler and the time that the reply of Kepler's secretary was on its way. Father Serarius could not wait. If he published Kepler's letter to Scaliger, it would be in the book he was writing against Scaliger. He had promised this book, his *Minerval,* for the coming markets. In consequence, he abandoned the idea of including Kepler's letter, and sent his manuscript to the press without it. Unfortunately, he had already mentioned the letter to his printer, and the announcement of his forthcoming book promised that it would contain a letter by Kepler in condemnation of Scaliger's chronology.

Kepler returned to Prague on the night of September 26. One of the first things he did was to write to Scaliger.

Most Illustrious and Erudite Scaliger:

> After I had written to you, five months ago, about the Attic year – influenced largely by the advice of those with whom I discuss things mathematical, – leaving Prague behind, I journeyed to Styria. There, word was sent me of a letter from Nicholas Serarius in which he informed me that my letter had been made accessible to him by a mutual friend, and that he wished to print it; that he would edit it, if I wished. I wrote back that he was not to do so; for I did not know the man, and did not want to mix private with public affairs. Notwithstanding, he has used my name in the recent market notices. Therefore, I write this to you, that you may know that it was done unknownst to me.

While Kepler worried about what Scaliger would think of him, the stars twinkled on, and the planets wandered. But his New Star was growing fainter; he saw it for the last time, low in the sky, in the west, on October 8, 1605. It was a good riddance; he had to concentrate on a coming phenomena. There was to be a solar eclipse on October 22. Kepler had already exhorted astronomers to watch carefully, to look for a circle of light around the black disc of the moon, and to endeavor to ascertain whether, if it were there, it were in the region of the moon or – a thing he did not believe – 400 times further away, as Clavius might claim, and part of the sun itself. On November 11–12, he wrote an open letter to astronomers, especially to those along the line where the eclipse would be seen as total, inviting them to send him the results of their observations. He had it printed as: *A Letter of Johann Kepler to Lovers of Things Celestial, especially to those dwelling in Northern Spain and Southern France and the Islands of Sicily and Corsica, about the Eclipse of October, 1605.* Then he had an idea; he would send a copy to Father Ziegler through Father Serarius. He wrote to Father Serarius, saying he wished to confirm what he had asked his secretary to write. Kepler also expressed the hope that his answers to Father Ziegler had been adequate; and that Serarius might be interested in the *Letter about the Eclipse of 1605.* Father Serarius replied: it was kind of and unnecessary for Kepler to have written; the answer of his amanuensis was sufficient; he had already abandoned the idea of publishing

Kepler's letter to Scaliger when he received this answer. Father Serarius enclosed a letter from Father Ziegler to Kepler.

Father Ziegler was an ardent young astronomer, in his middle thirties, as was Kepler. He thanked Kepler for his precise and sufficient answers to his questions, and for the added kindness of "the public letter and your own observation of the eclipse." For his part, he had written to Father Clavius calling his attention to Kepler's *Optics,* and, in particular, to what Kepler had to say of Clavius' description of the eclipse of 1567; he hoped to hear from Clavius. He had also written to all the Jesuits whom he knew to be interested in astronomy, asking them to send their observations of the eclipse of 1605 to Kepler. He enclosed a description of this eclipse, as observed by Stanislaus Crzistanovik in Flanders.

Kepler was extremely pleased. He found Crzistanovik's description of the eclipse, which was partial as seen from Flanders, a confirmation of Jessen's observations of 1598. The Emperor's sacristan, Harm, had seen the total eclipse from Naples, and found that Kepler's Plutarch described it exactly. Comparing the descriptions of eclipses of different times as seen from different places, Kepler built up a good argument for the brilliance round the moon not being due to the earth's atmosphere (which he reckoned to be not more than a thousand paces high). He also found reasons (which were not sound) why it could not be the sun itself. He concluded that it was the illumination of the "ethereal substance round the moon" (as he now called it). As the extent of the brilliant illumination was different at different eclipses, he concluded that the ethereal substance was different at different times. In particular, it was more dense in 1605. He wrote his thoughts to Father Ziegler, and added: "All this, with its implications, compare with Aristotle, and ask yourself whether the ethereal substance suffers alteration." It is noteworthy that he assumes that Father Ziegler, the mathematician, is an Aristotelian. Father Serarius, the theologian, had insisted that he himself was neither mathematician nor Aristotelian. It was to Father Serarius, the non-Aristotelian, that Kepler sent his letter for Father Ziegler expounding his

theory about the ethereal substance. Kepler may have been hard put to think of what to write in the covering note to Father Serarius. However, his ever ready friend Matthew Wackher von Wackenfels, with the tortuous mind, had an idea. Nobody in Prague seemed to know who this Michel Coignet was, who had a book out on the recent eclipse. Why not ask Father Ziegler through Father Serarius? That Kepler did, and in August, 1606, Father Serarius replied:

> Whether that M. Coignet was black or white, I did not know before. But in the past few days the distinguished mathematician S. Adrian Romanus was here, and he told me two things: first, that the man is ranked high as an astronomer, and secondly, that he is a man whom they snatch one from another.

And, with that he returned to his own muttons: "Have you seen that English thing against Scaliger? . . . I suppose you have heard of the storm that is about to break over Scaliger's genealogy?" This was all very interesting, but Kepler was more interested in reading what Father Ziegler had to say. Father Ziegler was working for Kepler, but without much success. It was five months since he had written to Father Clavius, and he had not yet heard from him; Crzistanovik had gone to Paris, and Father Ziegler had asked him to seek further information on the eclipse of 1605, and write to Kepler if he got any. Father Ziegler sent Kepler a copy of the second edition of Clavius' *Practical Geometry,* which he had published at Mainz. He also sent a drawing and description of a compound halo which he had seen in the sky on June 20. He included with these gifts a strong hint:

> For a long time I have been inquiring at our printers for your *Cosmographic Mystery,* published in the year 1596, and am still left with my desire, born of reading your *Optics,* and stimulated by your letters.

Kepler was not deaf to the hint, as we shall later see.

CHAPTER III

THE NEW STAR

Kepler wished to have many correspondents. He wished to have them feed him facts, facts which he could assimilate and digest and form into ideas. He was a theoretical, not a practical astronomer. By nature, he was awkward; by circumstances, he was devoid of instruments. He knew all this; and he made the most of what he had. His greatest asset was a rapid pen. He wrote to one of eclipses, to another of astrology, and to a third of chronology. To none did he open his whole bag of tricks. His correspondents were not necessarily friends. But there was one, his patron Herwart, who showed himself a true friend. In consequence, to Herwart he wrote most often and of many subjects. He did not tell him everything. He told him of his sojourn in Styria in the summer of 1605; but he did not tell him that there he bought a book which tried to prove that Christ was born in 5 B.C., and that he hoped to surprise the reading public with his dissertation on this book. The book was a published thesis which had been defended by Lorenz Suslyga, at the University of Graz, with the Chancellor of the University, Father Jean Deckers, S.J., presiding. Herwart soon heard that Kepler was working on it, for gossip traveled fast between the courts of Europe; and in May, 1606, he wrote to him:

> Pistorius tells me that you have written about the Attic year against Scaliger, and that he had some discussion with you about the opinion of Father Jean Deckers on the year and day of the birth and death of our Lord Jesus Christ. I would like to see your reason and decision on these questions.

Kepler's reply to his patron was peevish.

> I wrote about the Attic year to Scaliger, not against him, privately, not publicly. I was deprived of hope for a reply by my friend Nicholas Serarius, who made mention of me in an inopportune place, namely, in *Minerval,* on page 87 or 78, if I'm not mistaken. My point was that the early Greek year was not that which Scaliger made out, but that which Numa brought to Rome. I prove this not by my own, but by all the authorities which Scaliger thought proved his form.

The inopportune mention, to which Kepler referred, was in Serarius' *Minerval,* page 75. Father Serarius said Scaliger's Attic year would soon have to undergo an emendation, namely, as soon as he read "what His Majesty's diligent Mathematician, J. Kepler, has written about it." To Serarius, Kepler was grateful for not having printed his letter; to others he grumbled because his name had been dragged into a book antagonistic to Scaliger. In his letter to Herwart, he continued:

> About the birthday of our Saviour Christ I am writing an appendix to my book about the New Star, with an opportune connection, and there I defend the opinion of Joh. (*sic*) Suslyga, of Poland, propounded in a disputation under the presidency of Decker. The president is said to be the author; but I suspect Possevino made Suslyga the author of the book — its form and title point to Possevino.

Father Possevino was known to Kepler by his *Preparation for the Study of Scripture,* a bibliography of about 8000 works and published in parts at Venice between 1603 and 1606. Father Suslyga was unknown to Kepler. In 1602, King Sigismund III of Poland married Constantia of Styria, his deceased wife's sister. When Constantia came to Poland, Lorenz Suslyga was in her entourage. He returned to Graz to continue his studies, and in 1605, at the age of 35, he was a candidate for the degree of bachelor of theology. In partial fulfillment of the requirements, he defended Father Deckers' thesis on the date of the birth and death of our Lord. Having obtained the degree, he retired to Poland and there became a Jesuit. If Father Deckers was known to Kepler, he had not met him at Graz in 1605. Father Deckers could have assured Kepler that Father Possevino had nothing to do with his work, and, probably, that he had never met the

man. Father Possevino was Nuncio and Vicar Apostolic of Scandinavia when Deckers was a novice at Naples, and their paths do not seem to have ever crossed.

In September, 1606, Kepler had finished his book: *On the Star in the Foot of the Serpent-Holder.* The title page announced: "There are added: I. On an Unknown Star in the Swan: An Astronomical Narration; II. On The Birth Year of the Saviour Jesus Christ: A Consideration of the Most Recent Opinion of Lorenz Suslyga of Poland." As an ornament on the title page, there was a sketch of a hen scratching in a farmyard for grain, with the caption: "Grain is found by searching dung." A subheading announced that it was "A Book Full of Astronomical, Physical, Metaphysical, Meteorological, and Astrological Discussions, Glorious and Unusual." It was all it claimed to be.

The early chapters told the story of the appearance of the Nova in October, 1604, in the region of the three major planets. Much space was given to its astrological signification, two whole chapters being devoted to a refutation of the astrology of Pico della Mirandola. At length came the astrophysical question: whence Novae? Kepler rejected Brahe's theory that Novae were formed from the milky way, as well as the suggestion of Lervitius that they might be former stars or comets come back. He was of opinion that they were formed "from the material of the heavens." The twenty-third chapter was entitled: "The Material of the Heavens Is Alterable." Kepler began it with a confession. "I am not unaware," he wrote, "how distasteful this opinion is to Aristotelian philosophers." Distasteful or not, they would have to swallow the facts, the ether between the stars did change in density, and could even form New Stars. He brought forth examples:

> I. First of all, as an instance, I offer the prodigious mist of 1547, about which Gemma Frisius and his son tell, when for three days the sun looked as though it were sprinkled with blood. And that was observed not only in Belgium, but also throughout France, Germany, and Britain, as Scaliger testifies. . . .

> II. The second argument is the generation from ether of comets, which the established theory of their parallax show to pass through the field of ether, and, having suddenly become remarkable, to fade gradually until their material is finally dissipated. . . .
>
> III. A much more efficacious argument is presented by their tails (which change in length). . . .
>
> IV. And I add a fourth argument, drawn from the eclipse of the sun which we saw last October. . . .

His argument from the eclipse was almost a transcription of the letter he had written to Father Ziegler a few months before. He had but two descriptions of the eclipse to bear him out; that received from Harm, and that made by Crzistanovik. But he did not mention either of these men, or say how he came by their narrations.

The twenty-sixth chapter posed a question: "Was it by chance that this star appeared at the time and place of the great conjunction?" The great conjunction, the close approach of Jupiter, Saturn, and Mars took place in October of 1604; at that time, the Nova appeared in the same region of the sky where Jupiter and Saturn and Mars were. After one month it ceased to be visible for a couple of months; then it reappeared as a morning star in the east. Nearly two years after the great conjunction, it was lost to the view of man, while low in the west.* Kepler suggested that, perhaps, the Star of Bethlehem had appeared under somewhat similar circumstances, not by chance but by decree of Divine Providence. He argued thus:

> If that Star appeared first in 7 B.C. at the time of the great conjunction and (as we shall suppose for the present) in the same region of the sky, certainly the Chaldeans, from their own very rules [of astrology], as they still exist to-day, would have been warned of the greatest happenings, and of the universal renovation of the whole world. But that would be two years before Herod massacred the children around Bethlehem; and when these two years were up, the Magi came to the Crib of Christ in Judea. They came then in

* On a photograph taken in red light at Mount Wilson Observatory in 1942, a trace of Kepler's star is believed to have been found. A minute mist was detected very close to the position of Kepler's star as given by Kepler.

5 B.C. Now confer, and read what Lorenz Suslyga, a Pole, has to say of this date. His thesis, published at Graz in Styria, is backed by weighty arguments from history [but when Kepler the astronomer read what Suslyga had to say about the year of the Passion, he threw away his book and pen, and jumped up from the table in disgust]. You will find yourself persuaded that Christ our Lord was born, not in 1 B.C. but in 5 B.C.; and so the star, which began to shine two years before, appeared precisely at the time of the closest approach of Saturn, Jupiter, and Mars in 7 B.C., and in this respect, as has been said resembled our modern star. And since the star of old was divinely revealed to the Magi, it gives authority to the contention that God accommodated Himself to the rules of the Magi, to this extent, that the star shone forth at that time when the Magi most expected a star. Perhaps also, as has been said, it appeared in that region of the sky to which the eyes of the Magi were chiefly directed, because of the close approach of the three planets, as did our modern star.

When he had to face the question: what does the Nova of 1604 portend?, Kepler first became frivolous. It portended, he said, good business for booksellers, because every theologian, philosopher, physician, mathematician, and scholar would have his own ideas, and would want to publish them. Innumerable others would wish to know what these men would have to say. Printers and publishers would thrive on the New Star. Present political events were, scarcely, foretold by the star; or else, it augured ill for the Empire – since its rise, the Turks had found a most valuable ally in Stephen Bocksai of Transylvania. But Kepler doubted if passing events were the principal news of a startling New Star.

The thirtieth, and last, chapter of the book on the Nova was on the principal purpose of the New Star. Kepler began by disposing, with short shrift, of the shortsighted predictions of Röslin. On October 14, 1604, that is, three days before Kepler had seen his Nova, Röslin had written a letter about it, which was afterward published, without his knowledge or consent. In it he expressed the view that the New Star presaged the triumph of the reformed religion and the end of religious controversy. He pointed out how dissenters were being silenced. In England,

the Jesuits were banished, and King James had squelched Calvinism by his Hampton Court Conference; in Belgium, Spain was losing her hold – Maurice of Nassau had defeated a Spanish force and captured the important seaport of Sluys.

But when Kepler wrote two years later, he was able to point out that all was not quiet on the English front; that rumblings could still be heard across the channel – very audible, indeed, was the gunpowder plot of November, 1605. In Belgium, the Catholics under Spinola had done better than Sluys; they had captured Ostend. Religious discord was still rife; in fact differences asserted themselves with a vehemence more embittered than ever. There was need of a Saviour; Kepler wishfully hoped that the New Star might augur the rise of one. These words were his cue to air his exotic reading.

On the idolatry of Indians and remedies for it, it is not out of place to refer to what Joseph de Acosta (a Jesuit) has written about procuring the salvation of Indians, in the fifth book (of *Natural and Moral History of the Indians*). In Chapter IX, he says: "Indeed I do not know words with which to describe those souls, not so much imbued with, as entirely transformed into, idolatry, so that neither in leisure nor in work, neither in public nor private affairs, do they do anything without first having recourse to the superstition of their idols. . . ." And, having related almost infinite kinds of idolatry in use amongst them . . . afterwards, in Chapters X and XI, he takes upon himself to explain the remedies against idolatry, and finally adds this: "It is much to be desired that salutary rites be introduced in place of noxious ones, and ceremonies be replaced by ceremonies. Therefore, priests should persuade themselves how opportune are the uses of holy water and statues, and rosaries and beads, and candles and palms, and all other things which are approved by holy Church and bring neophytes around. Moreover, they ought to praise these things highly in popular sermons, so that the old superstitions may be supplanted by new and religious signs. . . ." Thus far Acosta.

Kepler's point was that God might use superstitions to raise the souls of men to higher things. He was arming himself, he thought, against Catholics who condemned astrology.

His appendix on the birth year of our Saviour Jesus Christ was printed separately. When he sent the manuscript to the printer, he forgot to send the title page. In the dedicatory letter he spoke of entering "a chronological forest." The printer seized on this expression, and used it as a title. Kepler was not amused when people referred to his *Chronological Forest;* it was not the correct title of his book, but it is a convenient title to use, to avoid confusion with a later work.

The *Chronological Forest* was dedicated to Johann Barwitz, the Emperor's Councilor, who had obtained for Kepler leave of absence from Prague in the summer of 1605. To him Kepler wrote:

> When last summer I went to Styria about family affairs, with His Majesty's indulgence and permission, obtained through your Lordship, a piece of good luck befell my studies. I found for sale at Graz a little book of Lorenz Suslyga, a Pole, entitled *Theorems about the year of the birth and death of the Lord, and about the whole chronology of Jesus Christ in the flesh.* Wonderfully pleased with this work, I began to think of accommodating it to my little book on the New Star in the Serpentholder, which I was then contemplating. For, if the author was correct, in order to reckon the age of Christ, four years must be added to the epoch of Christianity now in use. It would follow, therefore, that Christ was born one or two years after the great conjunction of the three superior planets in the first part of the Ram or in the end of the Fishes, occurring for the sixth time since the foundation of the world. Hence, the star which led the Magi to the crib of Christ, if it occurred two years before the birth of Christ, could be compared with our star.

It is to be noted that in this letter by "the Epoch of Christianity" is meant the beginning of the Christian era. The Epoch of Christianity now in use (and in use in Kepler's time) is December 25, 1 B.C. To understand the reference to "the sixth time since the foundation of the world," one must know something of the astrologers' trigons. The astrologers divide the twelve signs of the zodiac into four trigons (triangles), each of which contains three signs, thus:

Fiery Trigon:	The Ram, the Lion, the Archer
Earthly Trigon:	The Bull, the Virgin, the Sea Goat
Airy Trigon:	The Twins, the Scales, the Water Carrier
Watery Trigon:	The Crab, the Scorpion, the Fishes

Since the consecutive order of the signs in the heavens is the Ram, the Bull, the Twins, the Crab, the Lion, the Virgin, and so on, the Fiery Trigon consists of the first, fifth, and ninth sign. Now, the great conjunction takes place roughly every twenty years, each time about eight and one tenth signs from the previous place. If the great conjunction takes place in the beginning of the Ram, the next one should take place in the Archer; the next in the Lion; the next, three tenths of the way into the Ram; the next, four tenths of the way into the Archer. Going on in this way, it will take the conjunction two hundred years to pass over to a new Trigon, and eight hundred years to start the same cycle over again. Kepler took 4000 B.C. as the date of creation of man, and also supposed that the great conjunction took place that year. Then each 800 years he found some striking personage arise and some never-to-be-forgotten fact occur.

4000 B.C.	Adam
3200 B.C.	Enoch
2400 B.C.	Noe
1600 B.C.	Moses
800 B.C.	Isaias
———	Christ
A.D. 800	Charlemagne
A.D. 1600	Rudolph II
A.D. 2400	Where shall we be? And our now most flourishing Germany? And who shall be our successors? And will they remember us?

In fact, this simple theory of the astrologers (and of Kepler) as regards the 800 years, and "the sign and a tenth," is far from being accurate, and is not regular. Kepler did not elaborate this neat scheme in the beginning of his *Chronological*

Forest. At the entrance to his chronological maze, he explained to his readers why he rehearses Suslyga's arguments:

> It is not so much by want of matter as by a strange zeal that I am impelled to repeat the reasoning of Lorenz Suslyga, the Pole. For I desire that his way of thinking, which in my opinion is the correct one, may become known to as many men as possible. And truly, I fear lest it should not, chiefly for four reasons: firstly, because the new author's book carries the name of chronology, a science in which few are versed; secondly, because the author has against him the prejudice of outstanding men; thirdly, because he neglects astronomy, and in his argument about the year of the Passion positively prefers tradition to this science; finally, because it is difficult for a new and unknown author to convert the minds of men from an accepted opinion stabilized by the consent of many.
>
> These difficulties have already been provided against, to some extent, by Possevino, who has publicly commended the author; but he has left the point at issue intact, not inclining to either side.
>
> Therefore, it is not without reason that I hope by transcribing Suslyga's opinion into this book (which, because of its curiousness, I expect to come into the hands of many) to make it better known, to help it by adding astronomical arguments, and also to make it more conformable to truth by subtracting one year from the date of the death of Herod.

Kepler maintained that Herod died in 4 B.C., and not in 3 B.C., as Suslyga defended. Suslyga cited an eclipse in 3 B.C., which astronomy did not recognize. As a consequence, Kepler concluded that Christ was born not later than 5 B.C., and perhaps in 6 B.C. He finished by saying that our Lord was 32 years of age, or a little more, when he was baptized and began His public life in the year A.D. 28. There he stopped – saying nothing of the date of the Passion.

With the book finished and printed, Kepler was free to turn to his correspondence. Among the first, he wrote to Fathers Serarius and Ziegler. He thanked Father Ziegler for his efforts to secure descriptions of the eclipse of 1605, and he assured him that he was eager to receive more. He also thanked him for the copy of Clavius' *Practical Geometry,* and showed his gratitude in kind.

> I will take this occasion to send you the *Cosmographic Mystery* and a book about the star and the birth year of Christ, in which I disagree with Suslyga, the Pole, a pupil of your Deckers, as regards part of his book, so that I seem to go one better than him by one year.
>
> I said "in part of his book"; for what Hercules could oppose that prodigious galaxy of all antiquity, which I indeed treasure as though a gem, and which I wished to have in my library? Its style has all the exuberance of youth, and abounds in allegories, which, it seems to me, ought to have been omitted in a thesis not yet proved. But the matter itself betrays Deckers as the author.

Five months before, Kepler had concluded that the form and title of the book indicated Possevino as the author; now, he took the florid style to be that of a junior – possibly he never learned that Deckers' pupil was not a youth, but a mature man of thirty-five; later, when he had seen letters of Deckers, he must have realized that the flowery style was typical of him. Meanwhile, continuing to Ziegler, he indulged in a flourish himself.

> You crown your letter with a most beautiful end, the description of the unusual iridescent arc; of the nature of such, I gather, we are woefully ignorant. I know not whether our wondering says this to us: let optics be silent, when God is speaking.

On the very same day that Kepler wrote this, he wrote to Thomas Harriot of London:

> You know how varied are the genera and species of rainbows; to them I add one, which, on June 10/20 last, was seen at Mainz. It was an arc of most beautiful colours curving in both directions from its vertex, and seen in the direction of the sun in a wet sky, at some height above the horizon. You, therefore, O Excellent Priest of the Mysteries of Nature, pronounce the cause.

Harriot knew enough about iridescent arcs to know that one seen in the direction of the sun was not a rainbow. But, he was asked about rainbows, and he aired what he knew. What he knew is of interest in the history of the theory of the rainbow; he wrote to Kepler:

Nevertheless, I now say this about the rainbow: its cause is to be found in one drop (of water), it is due to reflection from the concave surface, and refraction on the convex.

It was not until December, 1606, that Harriot wrote this. Going back to October, we find that Kepler had more to say to Fathers Serarius and Ziegler. Commenting on Father Serarius' letter, he wrote:

I was grateful for the information about Coignet, and the more grateful because it came from Adrian Romanus, whose earnestness in such observations is not unknown to me. Your effort will be useful to me in writing a letter which I am addressing to Coignet.

I bought the Englishman Lydiat's book as soon as possible. He took some pains in reading, weighing, and castigating Scaliger's work on *Dates*. And so he was able to use some of that author. But in the text, the full promise of the title is not fulfilled. Indiscriminately he dethrones one tyranny, and sets up a new one. More honest was tyranny under the frequent flow of Scaliger's words, it was borrowed from none, it was masculine; and for it, Lydiat insinuates the arrogant and almost intolerable tyranny of his doxy, of a most fastidious woman, who always seems displeased. No wonder, with such ignorance of astronomy, and so great a beam in his own eye, I miss the modesty of the man in casting the mote from the eye of Scaliger. But to anyone who undertakes this task, with modesty, I promise my help, more by my mathematics than by my erudition, of which I am lacking. But that such writing should succeed, there is need for Scaliger's works, which can be had from libraries, or from some descriptions, as the Ignatian Letters. But it is of some importance, who writes these notes; on all sides you see minds filled with prejudices, and preoccupied with hate. If a Jesuit writes, it is reckoned as not written by those among whom Scaliger reigns. This moved me (if, digressing from Scaliger, I may come to myself) to edit what Suslyga, under the presidency of your Deckers, wrote about the birth of Christ. I seized the opportunity of my book about the Star to broadcast it to my people, among whom I was born and educated and to whose church, by the will of Christ, I cling (excepting particular heresies, which anyone at any time points out to me), that I may spread the doctrine which in my judgment is true, although detested by its adversaries. About my book, about it all, especially about its implications, I look forward to the physical, ethical, theological, and political judgment of the learned Master Serarius. I long for it with desire beyond your understanding; nor am I so sensitive as to pray to be excused from the sting of words (as long as they are in private letters), as, for instance, my astrology might provoke. With this liberty, I hope, you will hold yourself less excused – among the good, all is praiseworthy. To me it seems, my "grain from Arabian dung" is in accordance with the rules of your Del Rio. Write what you think, address your letters either to Marnius' book store, or to your college, to be kept for me. I would prefer the latter, for from there, perhaps, they could be forwarded to me. For, because the plague persists, I am leaving Prague with my family; the Emperor has already left.

Whether Fathers Serarius or Ziegler wrote to some of their colleagues in Prague suggesting that they try to point out some of his heresies to Kepler, we know not. We do know that Father Ziegler did not write to Kepler again until a comet crossed the sky and blotted out the memory of the New Star; and that Father Serarius did not acknowledge Kepler's letter until six months later. He declined, with thanks, Kepler's invitation to write a critique of his book: "Who am I, to pass ethical, physical, and theological judgment on so great a matter from the pen of so diligent and authoritative a writer?" Possibly he waited six months so that the book about Scaliger's genealogy would be in circulation. *The Suppositious Scaliger* by Kaspar Schoppe (Scioppius) was published in 1607. Father Serarius wrote to Kepler: "All, and they are many, who have read *The Suppositious* of Schoppe, affirm that the illustrious mask has been illustriously drawn from Scaliger." Scaliger had boasted of his descent from the noble family of Scala; he had written a book about it ;he probably believed it; he had heard all about it from his father. Schoppe pricked the bubble; Scaliger's end in 1609 (the same year that Serarius died) was hastened by wounded vanity. In January of 1609 Father Ziegler wrote his last letter to Kepler. Its main purpose was to acknowledge receipt of a copy of Kepler's book on the comet of 1607.

Your German book about the comet was most welcome, but, I regret, the second four pages were missing, and so I could

not learn your opinion about the nature and material of comets. If you would send me an unmutilated copy, I would be pleased.

I cannot match your kindness, but I can make some return. Herewith our Father Clavius' book against Scaliger; it is bitter, I admit, and foreign to your moderation, perhaps; but, if you consult Scaliger's *Eusebius,* you will see that an acrimonius reply did not escape from Clavius, but was extorted.

Clavius' *Reply to Joseph Scaliger's abuse and calumny of the Gregorian Calendar* was published at Mainz — its dedicatory letter was signed by Father Ziegler. Kepler cannot be said to have made converts to his opinions at Mainz. Father Serarius in his last work, *Josue Explained From the Womb to the Tomb,* published a few months before he died, condemned, as contrary to Scripture, the theory that the sun did not move.

Already, in 1607, Kepler had learned that holding new opinions, as well as putting back the date of the birth of Christ, did not help to make friends and influence people. Rather, it exposed him to attacks from many sides. Thomas Lydiat, the learned Rector of Oxford, with obvious scorn, called Kepler's chronology "that of the Jesuits." Kepler, with the gibe still smarting in his mind, took up his pen to write a criticism of Lydiat's book. Judging, he said, by the way Jesuits are treated in England, it must be a great crime to hold Jesuit doctrine; but if Lydiat has no more serious charge against the Jesuits than that they approve the Keplerian chronology, by that very charge the conduct of his country stands condemned. When Kepler cooled, he abandoned his work against Lydiat — the little he had written did not come to light until two and a half centuries later. Kepler was too anti-Catholic to come out in favor of the Jesuits.

His anti-Catholic views were exposed, plain and unvarnished, in a letter to Pistorius, a letter written on Good Friday, 1607. Pistorius had written, from Freiburg, a friendly note that he was interested in the date of birth of Christ; and that, taking Father Deckers' date of 3 B.C. for the death of Herod, he thought Christ was born 4 B.C. It would all seem to depend on the date of the eclipse at the time of Herod's death. Would

Kepler let him know what eclipses of the moon there were in the years in question? He added that he was still interested in studies, though near his end.

I am confined to the house with a critical and most serious ailment, which, it seems, will end in death; for there is scarcely any other hope. I do not grieve, but prepare myself for that happy journey, which will free me from the inanities of the world and bring me to my Saviour, Christ, and my share of His celestial inheritance. Therefore, if it please God and be His will, may there be a speedy end to my illness!

These pious aspirations provoked Kepler to pen the most bitter and sarcastic letter he ever wrote. He had already been saddened, he said, by the news of Pistorius' conversion to the Catholic Church; now comes the news of his deadly illness. "I learned of this with grief; but I am consoled by your Eminence's lofty spirit and imperturbable desire for immortal life," he wrote and warming up, he continued in almost never ending sentences, with lengthy parentheses:

For this only do I sigh, that as God has determined for your Eminence and for the Church, so also He may know what is most salutary for me. And certainly I do not doubt that you are prepared by your trust in Christ the Saviour, and hope of a share in His celestial inheritance, and by your contempt, as you write, and, hate and regret, as I interpret, of the inanities of the world. . . . You will come, therefore, if fortified with these (for God is the judge of the hidden, and of secret sins), you will come, I say, to the company of the elect, and on the Great Day will bear witness before the tribunal of Christ, that I was never motivated by any private hate of the pope or bishops or priests, but solely by zeal for God, and for the commands and institutes of Christ, and by care for His warnings and those of the Apostles. . . . For these reasons, I say, I remained in the liberty in which, by God's permission, I was born, and did not wish to shackle myself with the foreign Roman yoke of those who burden Christians with non-essential ceremonies, not unlike those which St. Paul describes to the Galatians as burdens, and who interpret the words and commands most dangerously, alienating to themselves alone this right of interpreting — a right which, if granted, would make it possible for even Antichrist himself to establish his reign in the Church, and turn Christ out.

Though Kepler was bitterly opposed to the Catholic doctrine, he bore no grudge against those who held it. He was not displeased to see Catholics differ among themselves in nonessentials; and he had abundant evidence that they were by no means agreed about the date of the birth of Christ. In the twelfth, and last, volume of his *Ecclesiastical Annals,* Cardinal Baronius came out with a sharp attack on Kepler's chronology of the life of Christ. The attack has been read as a rebuke for Father Deckers, but in fact the doctrine which it attacked was Kepler's not Deckers, for it objected to moving the date of the birth of Christ back to 5 B.C., and leaving the date of the Passion in A.D. 33. Baronius' twelfth volume left his hands on May 24, 1607; its last few pages were in the nature of a postscript. On page 902 we read:

> Last year there was published at Graz, in Styria, a lengthy disputation, which opposed not only our chronology for the years of Christ and time of the Passion, but that of the Universal Church. It does not need our refutation, since the ears of the pious cannot admit, at least patiently, a rashly presumed novelty, which, first of all, contrary to St. Luke (testifying that Jesus Christ our Lord was about thirty when baptized), affirms that He was baptized when more than 32 years of age, and was crucified when already 36.

After upbraiding the author for leaving the customary teaching, he goes on: "St. Augustine teaches that what is strengthened by the custom of the universal Church is not to be set aside" — and he quotes St. Augustine to Januarius. Then he continues:

> But what we say is approved by the custom of the Church. Bede satisfies himself it is more, namely, of Catholic Faith. He says: "The Faith of the Church holds (unless I am mistaken) that our Lord lived in the flesh a little more than thirty-three years, to the time of His Passion."

He proceeds to build up his case, with further citations, and ends strongly:

> Whatever, therefore, are known to be contrary to this, must be corrected, not hesitating any more than if it was contrary to the faith (as Bede says it is).

The poor Cardinal must do much turning in his grave today, when so many Catholics believe Christ to have been born in 7 B.C., and to have died in A.D. 33, at the age of thirty-eight.*

On top of this, or before it, Kepler received a letter from Seth Calvisius, the first of a series, in defense of Scaliger's date of 2 B.C. for the death of Herod. All in all, Kepler was not finding many to go any distance with him. The Jesuits at Mainz were silent. It would seem that Kepler was disapproved; but if he was, so was Deckers. Hence, to Deckers Kepler turned, and about August, 1607, he sent him a copy of his *Chronological Forest.*

* If our Lord was born on December 25, 7 B.C., He would be thirty-eight on December 25, A.D. 32.

CHAPTER IV

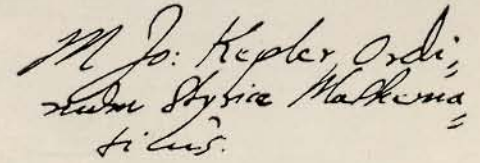
CHRONOLOGY

Father Jean Deckers was born at Hazebrouck, which, today, is on the railroad between Lille and Calais. All travelers who have been there have heard the cry: "Change here for Dunkerque." Hazebrouck rarely fails to make the news in times of war. In April, 1918, the German drive for the coast was halted five miles east of Hazebrouck. In July, 1941, the R.A.F. paid particular attention to this strategically important junction. The cockpit of Europe was seething also when Jean Deckers was a boy. On April 8, 1566, *Les Geux* took their name at Brussels. Four months later, there was an outburst of iconoclastic fury at St. Omer, ten miles west of Hazebrouck. It was the first spark of armed revolt in the Netherlands.

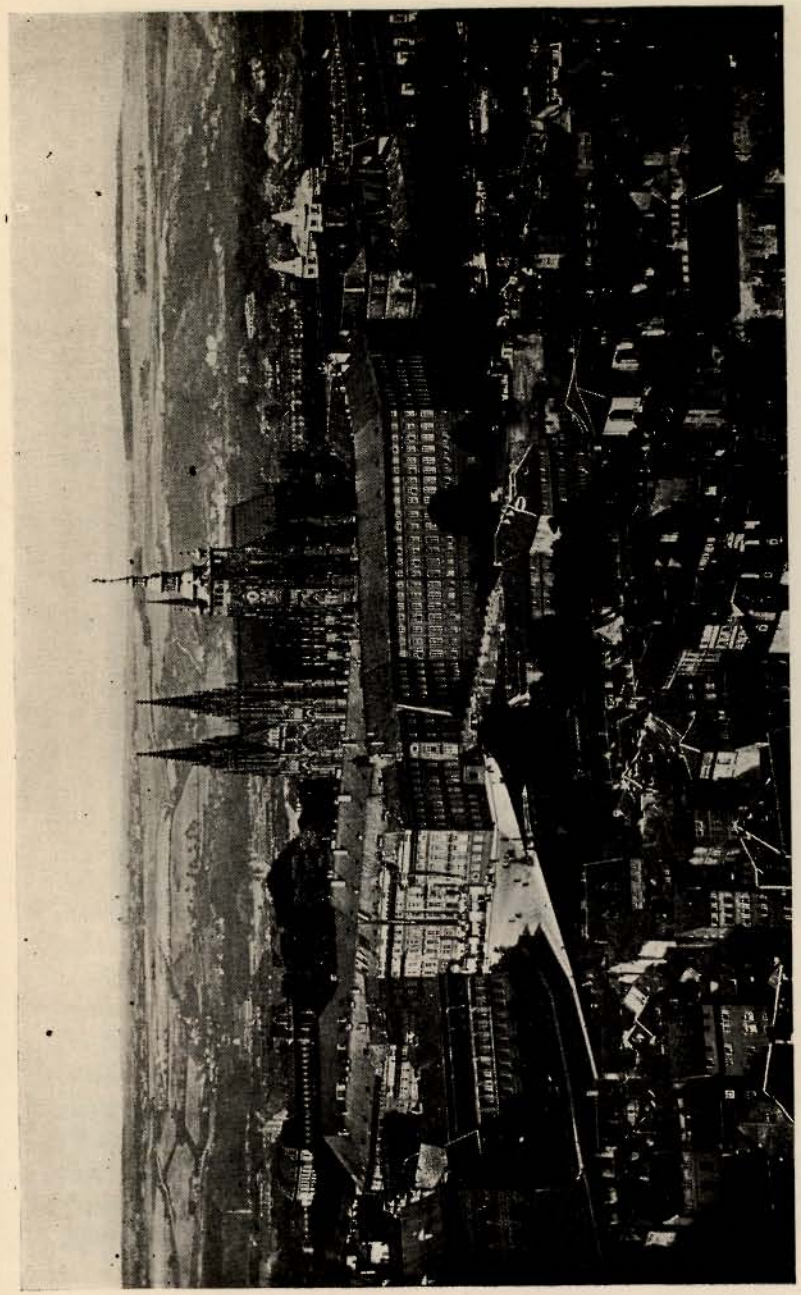
Deckers was then six years of age. His youth was spent under the iron rule of Alva. But there were in those days, and even in those places, other doings besides the forging of steel and shedding of blood. At Douay, the English College was opened in 1568, and Anchin College (for Belgians) in 1569. To the latter went Jean Deckers; and to the former, in 1576, went Robert Southwell. Both listened to the lectures of the young professor of philosophy, Leonard Lessius, a Jesuit Scholastic.

Southwell had thought of being a Jesuit, but for three months he was tempted (the word is his) to become a Carthusian. One September day he was talking to a Jesuit Father, when Lessius passed, walking with Deckers. "There," said the Father, indicating Deckers, "is one who for a year or more has been burning with zeal like yours to serve God, but who, unlike you, has never wavered." Southwell desired to meet a kindred spirit. Lessius introduced him to Deckers "in front of the chapel." "There we met," wrote Southwell, "and disclosed



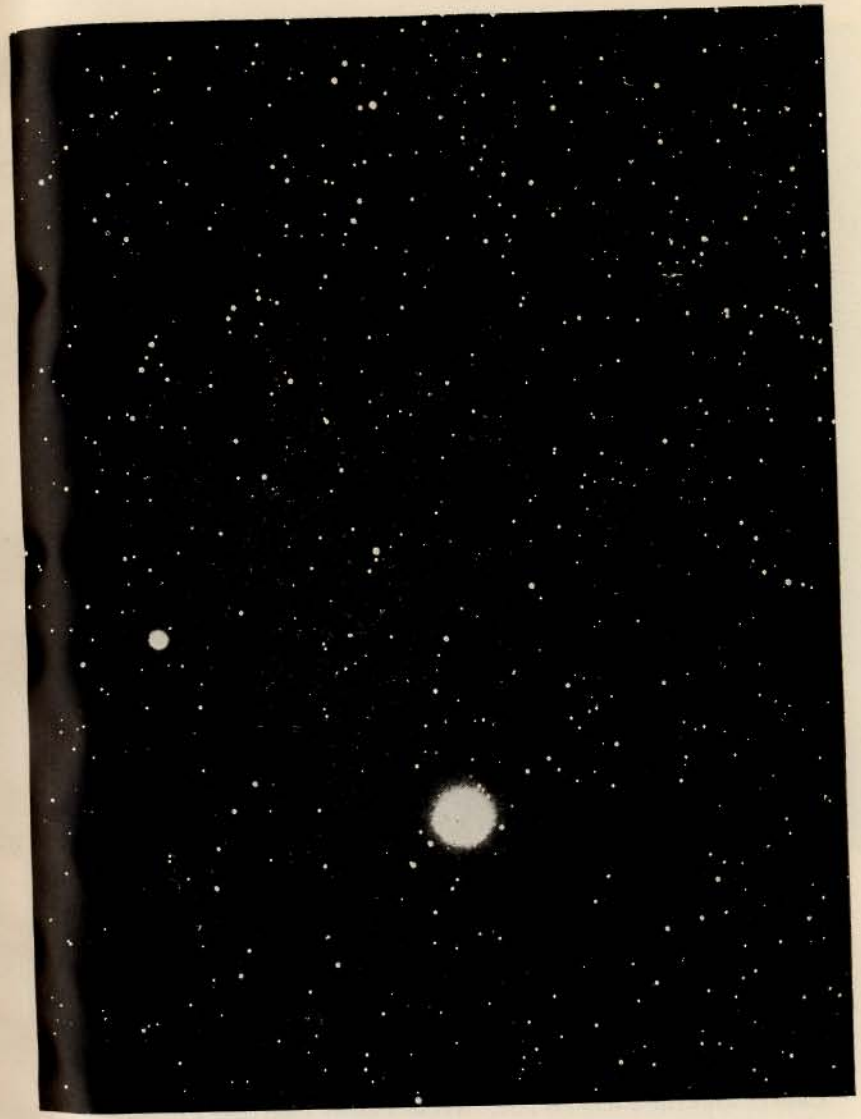


JOHANN KEPLER
The portrait was painted, three years before Kepler died, for the Strassburg Library. The signature is from a letter written thirty years earlier, when Kepler was Provincial Mathematician in Styria.



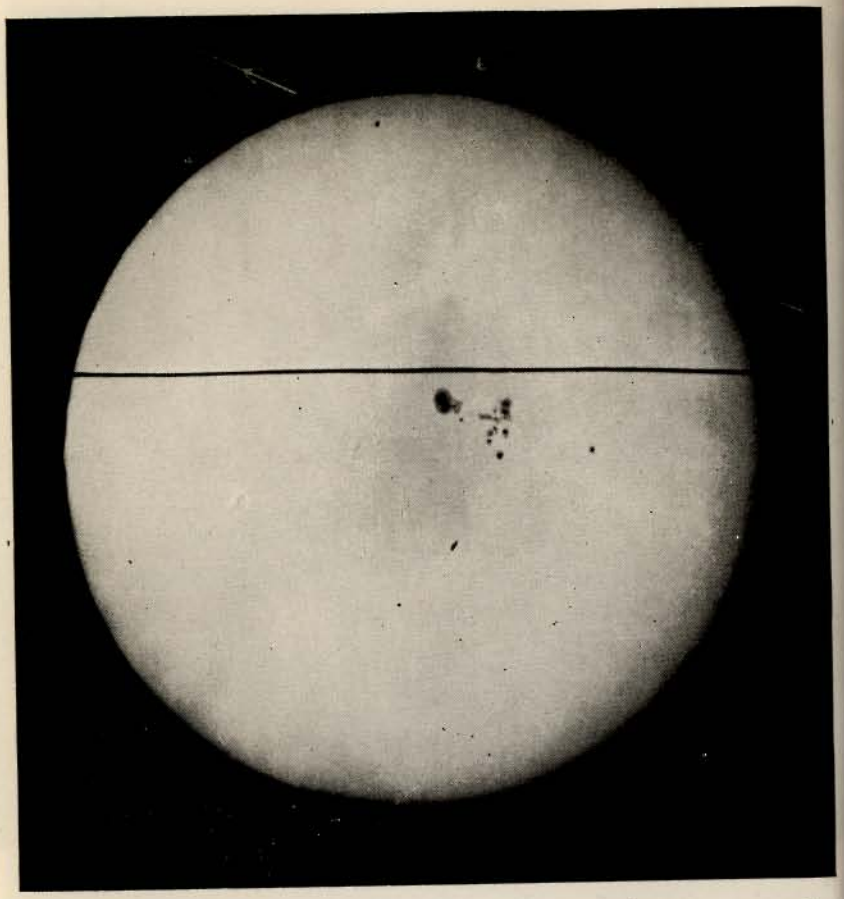
THE OLD QUARTER OF PRAGUE

In front of St. Vitus' Cathedral is the Imperial Palace, where Kepler had an office, and wrote his greatest works.

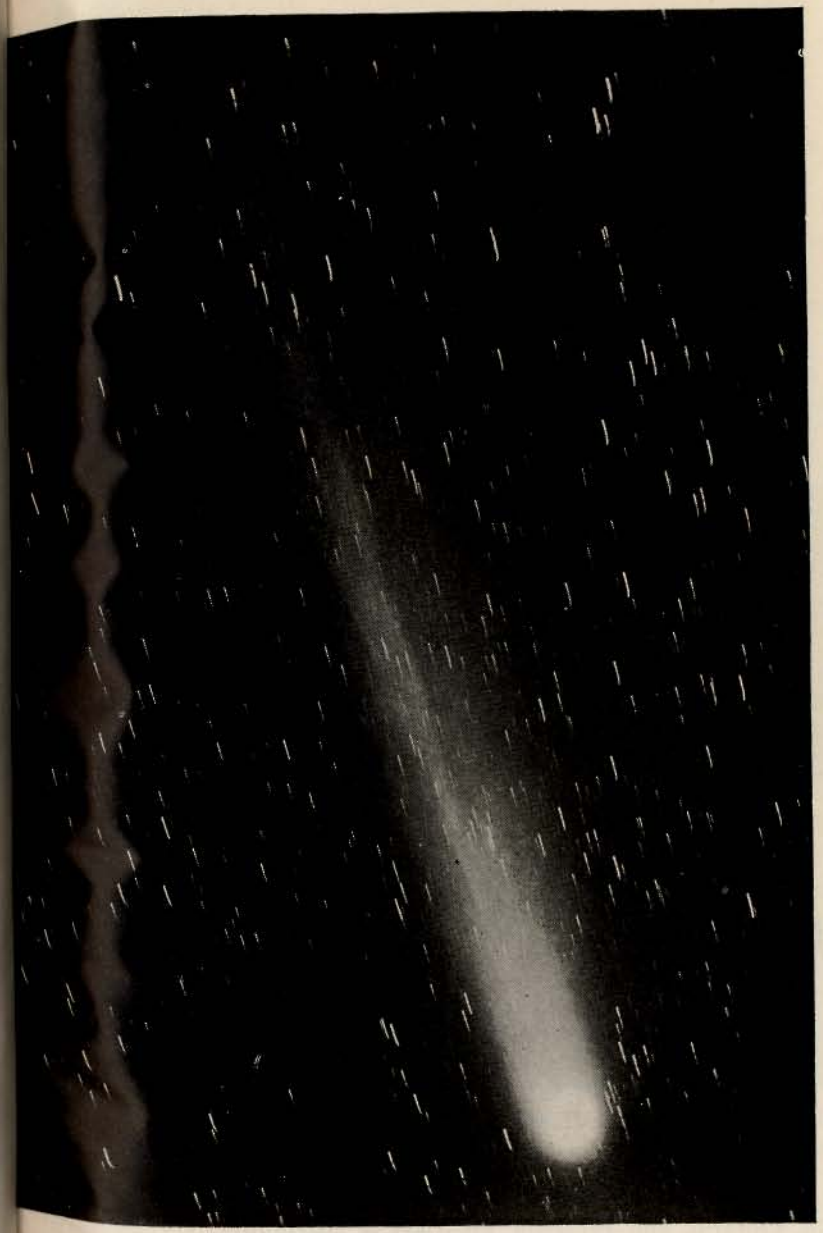


NOVA PUPPIS

This star appeared in November, 1942, with suddenness similar to that of Kepler's New Star in 1604. — Photo by Harvard College Observatory.



UPPER HALF: Mercury, seen as a dot, passes between us and the sun, November 14, 1907. LOWER HALF: Spots on the sun. In May, 1607, Kepler saw a dot on the sun, which he mistook for Mercury passing between us and the sun. The existence of sunspots was not known in 1607. – Photo by Yerkes Observatory.



THE COMET OF 1607 PHOTOGRAPHED ON MAY 29, 1910
This comet, studied in detail by Kepler, is now known as Halley's comet. It will be seen again in 1986. – Photo by Yerkes Observatory.



MONUMENT TO KEPLER

This monument stands in the market square of Weil, Kepler's native town. The photograph was taken in 1928 by Dr. C. A. Chant, Director of the David Dunlap Observatory, Richmond Hill, Ontario, and Professor Emeritus of Astronomy, University of Toronto.

to one another the desires and secrets of our hearts. . . . No friend was then so dear to Jean as Robert, none so dear to Robert as Jean. . . . Whatever free time we could steal for conversation together seemed all too short." Those happy days were shortened. Spanish troops had mutinied; there was talk of all foreigners being excluded from the Netherlands. Flanders was no place for English students subsidized by the Spanish monarch. About ten days after the "Spanish Fury" at Antwerp, when Oberstein and his merry men, including Heinrich Kepler, had been put to flight, Southwell left Douay for Paris.

Southwell returned to Douay in June, 1577. He was bent on going to Rome and offering himself to the Society of Jesus. Would Deckers come? Deckers would not; and Southwell set out with Matthew Marshall. During the winter, Deckers was filled with remorse for not having accompanied Blessed Robert. "Therefore, the difficulties of winter, its rains and snows, being overpast, after the clefts of the earth and the precipices, everywhere to be met with, were known to allow an easy passage to travellers, following your example, of which God was the Author," he wrote to Southwell, "I delivered myself to the same Author. I came to Rome."

Arrived in Rome, he found that his friend Robert had not yet been accepted into the Society — he had been deferred. Jean was accepted immediately, and dispatched to Naples to begin his noviceship. He was not given time to see his friend; nor was Robert sent to Naples when he was accepted into the Society on St. Luke's eve, 1578. What we know of all this, we know from the letters which passed between them in October, 1580, when Deckers was still at Naples, and Southwell at the Roman College.

Lessius, Southwell, and Deckers were, all three, students together at the Roman College in 1584, and had Bellarmine and Suárez as professors. Lessius left Rome for Belgium in May, 1584. Southwell and Deckers were both at the Roman College in January, 1585, when Southwell wrote to Lessius. That same year, Alessandro Farnese swept through Flanders, and made it a safer place in which to live. The following year Father Deckers

was professing philosophy at Douay, and Blessed Robert stopped there *en route* to England. He had money to finance the English mission, which he would have in safe keeping; so he confided it to Father Deckers, and set forth in peace.

From St. Omer Blessed Robert wrote back to Father Deckers and warned him to keep secret the news of his and Father Garnet's passage to England. On July 15, 1586, he wrote from Calais his oft-quoted letter "from the port." There is a passage in it which bears repetition:

> Being now exposed to the utmost dangers, I write to you, my Father, from the threshold of death, imploring the aid of your prayers that, as once you re-awakened in me the breath of life, when I was ready to die, so now, by your prayers, I may either escape the death of the body, or endure it with courage. I am sent into the midst of wolves, in the name of and for Him who sends – would that it were as a sheep to the slaughter. I know, of course, that many jaws stand open and gaping for me, both on the land and on the sea – jaws, not only of wolves, but also of roaring lions, seeking whom they may devour. My fear of tearing teeth is less than my desire for them; I do not dread the tortures as much as I look forward to them.

During the years that Southwell was daring death, Deckers had to give himself to the drab life of professing philosophy. His zeal had no England for a field. It found an outlet, however, in his first published work: *The Exercise of Christian Piety,* which was published in Cologne in 1589, and ran to a second edition ten years later at Louvain. Then he was promoted to a professorship in theology. In those times, teaching theology in Flanders was a ticklish task. In 1588, Douay University issued a monster memorial against the teaching of the Jesuits. Lessius' consoling teachings on grace and predestination had been called in question the previous year. Lessius, at Louvain, and Deckers, at Douay, were carrying on the teaching and tradition of Bellarmine, who had been at Louvain from 1569 to 1576; but they were not Bellarmines. They did not see, at first, that Molina's doctrine differed in any way from Bellarmine's. To Bellarmine, Lessius wrote on July 15, 1590:

> There suddenly comes to us from Portugal a work by Father Luis Molina, entitled *The Accord of Free Will With Gifts of Grace.* In this book, all those views which our friends the Doctors visited with their censures are most accurately explained and defended.

Deckers devoured Molina's book, and made its teaching his own, with unfortunate effects. In a public disputation, some of his pupils defended Deckers' doctrine. Dr. Martin Rythovius denounced the teaching in unmeasured terms, tore to pieces the notebooks into which it had been copied, and forbade the owners to go to any more lectures by the Jesuits. Father Deckers appealed to Rome; he claimed that he had taught nothing which Bellarmine had not taught. When Bellarmine demurred, Deckers accused him of having changed his mind. Bellarmine wrote: "Your Reverence thinks that I have changed my views about some doctrinal matters. . . . I think that it is you in Belgium who have shifted your ground after reading Father Molina." And he introduced a nice distinction.

> The statement in the *Ratio Studiorum* which says that of two who have the same help, one may be converted, the other not, is very true; but by "the same help" is meant the same interior *impulse,* and not the same *grace.* The same impulse will be congruous for one, and not congruous for the other, and certainly God gives more grace to him to whom He gives a congruous impulse, than to him to whom He gives a non-congruous.

Father Deckers was far from satisfied with this explanation; he emerged from the limelight of theological discussion describing St. Robert Bellarmine as a turncoat and dissimulator. A few months later (January 5, 1592), he became a professed father of four vows. Three years later, he was transferred to Louvain, to play second fiddle to Lessius.

The year 1595 was a momentous year. In March, according to the Gregorian Calendar, Blessed Robert Southwell was hanged, drawn, and quartered at Tyburn. He had spent three years in jail, and had been tortured thirteen times. Father Deckers collected what details he could of Blessed Robert's last

days. He conjectured that it was the attempted assassination of Henry IV of France, in December, 1594, which had stirred Elizabeth to increased severity. Appending Blessed Robert's letter "from the port," he sent to Father General Aquaviva his *Narration of the Martyrdom of Bd. Fr. Robert Southwell of the Society of Jesus*. From the time he narrated the hard facts of his friend's fate, until many years later, Father Deckers led an inconspicuous life. But he was not forgotten; when the Counter Reformation was making headway in Styria, and able men were needed, he was called upon to play a part. He was loaned to the Province of Austria, and was assigned to teach theology at the University of Graz.

In the catalogues listing Jesuits at Graz, Father Deckers' name appears for the first time in the catalogue for 1600, the year in which Kepler took up residence at Prague. In the catalogue for 1601, he is listed as Chancellor of the University; and Chancellor he remained until September, 1607. It was in 1605 that he put out the book which interested Kepler. Its title was, briefly: *Theorems on the Year of the Birth and Death of the Lord, and on the whole Life of Jesus Christ*. The book, the title page stated, was four theses defended by Lorenz Suslyga, with Father Deckers presiding. Kepler had defended theses; and he knew that the defender was not always the author. He recognized those defended by Suslyga as coming from the hand of a master. He suspected Possevino; but he was not talking. He was playing with his cards close to his chest; he was holding a surprise for the readers of his long-awaited book about the New Star.

In his book he compared his Nova with the Star of Bethlehem. This was no surprise. In 1572, men had wondered if Brahe's New Star was the Magi's Star returned; the Calvinist theologian Theodore Beza, in elegant verse, asserted that it was:

> This is that Star, which to the city small of David King,
> The three Wise Men sometime from out the East did thither bring,
> And that which once when Christ was born, did lead them with its light,
> Returning now declares, that Christ returns again in might.
> Wherefore your blessed crew of Saints, and godly men, be glad,
> And bloody tyrant Herod, stand in fear, and be thou sad.

The surprise which Kepler was holding in store for his readers was twofold: it was, first, that the Magi were aided by astrology in finding their Star; and, secondly, that Christ was born not later than 5 B.C. For light on this latter question, he was indebted to another; he was surprised himself to find that it was to Father Deckers.* It was not until nearly a year after the publication of his book on the New Star that he sent a complimentary copy to Father Deckers. Father Deckers acknowledged it from Olmutz, on September 7, 1607, to where he had gone recently as Rector of the Jesuit College. He wrote a most elegant letter of thanks. He was pleased that they agreed, substantially, on the date of the birth of our Lord. As regards the date of the death of Herod, he had "many and great" arguments for 3 B.C., based on a chronological table, compiled largely from Scaliger's *On the Emendation of Dates,* and Kepler's own *Chronological Forest*. He sent Kepler a copy for his inspection. If Kepler found anything which he could refute, would he, in a friendly letter, inform Father Deckers?

Kepler did inform Father Deckers. He informed him in a 2600-word letter, in which he reiterated that he could not overlook the testimony of Josephus and the eclipse as evidence that Herod died in 4 B.C. The bulk of his letter was taken up with the date of the Crucifixion. Father Deckers favored March 23, citing the *Acts of the Council of Caesarea,* quoted by Bede, as evidence that March 25 was the day of the Resurrection. Kepler pointed out that Bede himself was very doubtful as to whether the *Acts* should be followed on this point, and that Baronius definitely said: "No; they were approved by Pope Victor only in so far as they stated that the date of Easter was not to be com-

* For the former idea, he was indebted to St. Chrysostom, who deems it God's "great condescension" that He called the Magi "by means of their customary pursuits."

puted in the way of the Jews." And it is my opinion, said Kepler, that this *incunabula,* would be more kindly forgotten than dragged out to confuse our present-day discussions. In conclusion he added:

> Permit me to add something from the candor of my heart. The foundation of your disputation has all been beautifully laid by Scaliger in becoming style. . . . Now, even though he is a heretic, an innovator, a detractor of the Fathers, and granted that he has a faked pedigree, what has all this to do with the present question? Why can you not speak of him but disparagingly? . . . If you will listen to my advice, when you have to quote him, quote his own words. . . . Then he, by his own words, will protect himself sufficiently. . . . Does Scaliger destroy the tradition of the day of Christ's birth? But, you and I destroy the tradition of the year. We have Chrysostom on our side; he has Epiphanius on his. . . . If anything in my writings does not please you, or if I have anywhere tread on your toes, I ask by the law of retaliation that you will not hide the facts, but as soon as possible reply.

Father Deckers replied with a letter even longer than Kepler's, and which he trusted, he said, Kepler would keep confidential. As regards the Herodian eclipse, he answered: "It was well known to Pliny and Dion and other good authors that the word *eclipse* did not always mean an interposition of the earth or moon, but also an unusual dimming, due to the interposition of clouds or something of the sort." As regards the date of the Crucifixion, he quoted Epiphanius: "The Jews, in the year in which Christ was crucified, anticipated the pasch, eating it two days ahead of time; and Christ our Lord ate this Jewish pasch, with His disciples, not doing otherwise than did the Jews." "Furthermore," wrote Father Deckers, "of all the choir of Holy Fathers, none said, or taught, or learned, that Christ died in any other month but March, or on any other day but the Friday nearest the equinox." Coming to the question of Scaliger, Father Deckers accepted Kepler's invitation to use the law of retaliation.

> You say that Epiphanius is Scaliger's authority for his opinion about the day of the birth of Christ. What is this

> I hear? Scaliger would have Christ conceived in January and born in September. Which of all the Fathers ever dreamt of such a thing? To whose mind has it ever come that Christ was only eight months in the virgin womb? . . . Epiphanius slipped in mistaking the day on which Christ was baptized (according to all the Fathers) for the day on which he was born. Therefore he set down January 6 as the day of the birth instead of the day of baptism. . . .
>
> You say that Scaliger overturns tradition as regards the day of the birth; you and I, as regards the year. But God knows better. I never learned to overthrow the tradition of the Church, but Scaliger makes it his business to show that all Christianity and every Church has erred. . . . I do not reprehend Scaliger for putting the birth of Christ two years earlier than the generally accepted date . . . but for accusing the Church of error. . . . I advocate four years (twice as much as Scaliger) between the two eras, but I do not yell, as does Scaliger, that the Church has erred.

Before replying to this in detail, Kepler returned to Father Deckers the Chronological Table which he had lent him and promised a long letter. Father Deckers acknowledged receipt of his Table with: "I look forward with great avidity to your letter, from which, no doubt, some light will be brought to me." The promised letter was already on its way as he wrote this. It was a long letter, running to about 3400 words — we shall compress it to about 200 words.

> It matters little, I think, which of us triumphs over the other; I over you about the death of Herod and the birth of Christ in 6 B.C., or you over me about the Crucifixion in A.D. 31. If I can find no objection against Epiphanius, I shall pick up my pen, thrown behind the stove, and return quietly to my chair to continue reading you. . . .
>
> You did not understand me when I made Scaliger to contend with you. To you I attribute the day, to him the year. On the authority of Chrysostom you argue for December 25, and are angry with him for denying the authority, and besides authority bring forth reason. In precisely the same way, Scaliger stands up for January 6, on the authority of Epiphanius, and could be angry with you for not acknowledging the authority of Epiphanius on this point, and he adds astronomical reasons for his year. . . . You deny that you over-

throw tradition in denying that Christ was born in 3 B.C.; concede, then, that Scaliger does not upset tradition when he denies that Christ was born on December 25. . . . You argue as though his chief sin was that he said the Church erred . . . on the word "erred" you place all the stress, just as though Scaliger had said the error of the Church, as he called it, was in a matter of faith, just as though there were not degrees of error, light and grave. . . . But let us return, lest out of a chronological dispute we make an ethical one, out of an enquiry into truth, a defence of a man. . . . I pray you to send me from a Greek copy of Epiphanius a transcript of what he says of the Jewish calculation of their anticipation, and all you think of it. . . ."

The very same day, October 27, 1607, that Kepler wrote this letter to Father Deckers, he also wrote to Scaliger, his third and last vain effort to have this great man write to him:

Not without reason, Most Excellent Sir, do I suspect, from your silence, that you have begun to think ill of me because of the inopportune mention of my letter to you made by Serarius in his *Minerval,* without my knowledge, and with my regrets. . . . And I will not believe that you hate the source from which your accuser obtained his authority; I hope you will be the friend of fairness. As for the tragedy of your ancestry, what has that got to do with learning? That you may see what I think of this matter, this is what I hold: no one knows better than himself his ancestry; and since nowadays there are many means by which necessary documents can cease to be, it seems vile to me, after one hundred years of quiet and undisturbed prescription, to call in question a fact about which the witnesses are dead who were able, when they lived, to testify by their silent consent. . . . I wish that you would write to me, even if you begin with maledictions.

Now, as to dates. . . . About the year of the Passion of Christ, I do not think the opinion of Suslyga, whom I see that you have read, is entirely without foundation. He pretends, indeed, to be guided by the ruling of the Palestinian synod, which is ridiculous, pretending that this synod could be an authority on a thing which happened many centuries before; that the whole question depends on Epiphanius, he dissimulates. Epiphanius affirms that he saw a version of the *Acts of Pilate,* in which March 20 was given as the day on which Christ ate the Pasch. He adds that it was a Tuesday. It is certain that

Christ ate the Pasch on a Thursday; but we ought not to reject the year 31 because March 20 was a Tuesday. For, maybe for some reason, which Epiphanius suggests, the twentieth became the twenty-second, and Tuesday became Thursday. I will indicate two examples. . . . With these two examples, it seems likely to me that, as Epiphanius says, the Jews sometimes celebrated the fourteenth day of the moon, which fell on March 24, on March 22, and thus the Resurrection would fall on March 25, according to the old tradition. Besides, Epiphanius puts his faith in the year 31, found in the *Acts of Pilate,* although he had other evidence against it.

I wish, most diligent Scaliger, that you would weigh these facts, and, for the sake of truth, write to me, at your convenience, what you think.

Scaliger never wrote to Kepler. While he was waiting for a reply from him, and from Father Deckers, Kepler received the following from Dr. Joseph Brengger:

I see you do not agree with Suslyga about the year and day of the death of our Lord. I could not avoid laughing when I read what you wrote about this (how you jumped up from the table and threw away your pen and book in disgust). Following Christmann and Mother, I place the Passion in A.D. 33, on April 3. . . .

Kepler replied:

On the year of the Passion, Deckers is persuading me by citing Epiphanius; for the Jews used to anticipate two days. I have written to Deckers, if he can prove this from the Greek text of Epiphanius, I shall resume my pen and my book and return quietly to my desk to continue listening to him.

It was not until December 11, 1607, that Deckers replied. He yielded to Kepler on a minor point; he granted that the year in which Tiberius went to Rhodes was not 5 B.C., but 6 B.C. "And so," he wrote, "I freely yield to you, and surrender to the truth." But about the year of Herod's death he was adamant; Herod was seventy when he died, and he could not have been seventy, he said, in 4 B.C. And then he harped back to Scaliger.

You say that Scaliger may just as well be angry with me who will not stand by Epiphanius stating that Christ was born

on January 6. But no; there is disparity. The Fathers are with me, and all theologians of to-day; and Chrysostom and Jerome already warned that the whole world was against Epiphanius, who stood alone. But I hope in a future work to clear this up. . . .

You ask for the Greek words of Epiphanius with my brief notes and explanation. Those I would send you if anywhere here a Greek Epiphanius could be had; much more do I ask the same from you, who, doubtless, will find a Greek Epiphanius at Prague.

Kepler did not reply for nearly a year. He then excused himself on the grounds of "public and private troubles." The public troubles were not light, and culminated in Matthias' Austro-Hungarian army marching on Prague, where Kepler was. In November, 1608, he had time to pen a 5000-word epistle to Father Deckers. He had, meanwhile, obtained a Greek copy of Epiphanius from the Jesuit College at Prague, and had persuaded himself that March 23, A.D. 31, was the date of the Crucifixion. With the Greek text of Epiphanius, he had much on which to write; and he asked Father Deckers to write what he thought of his interpretations. But, a year had passed; it was now *vieux jeu* — Father Deckers did not reply.

Seth Calvisius had started corresponding with Kepler on the question of the dates of the birth and death of Christ, before Kepler contacted Father Deckers, and he continued his constant barrage until the end of 1610. In the troublesome year 1608, Kepler let Calvisius' letters accumulate, then he resumed his answering, letter for letter. Calvisius' arguments were of little avail. By defending, against Deckers, the possibility of 6 B.C. for the birth, Kepler had become convinced that 6 B.C. was right; and once perverted to A.D. 31 for the death, nothing could shake him; the more he defended these dates against Calvisius, in turn, the more he became convinced that they were right. His opinions became strong impressions, and by 1610 they were permanent ones. In that year, we find him writing a summary of the whole question to Marcus Gerstenberger, and quoting the *Acts of the Council of Caesarea* with great gusto as "the testimony of all the bishops of Palestine in the Synod of

Caesarea." His original judgment that these *Acts* would be more kindly forgotten was sounder. They were, for a long time, known only to Irish writers; they are undoubtedly forgeries, being probably concocted in the sixth century, possibly by an Irish monk, whose unguided piety would have none deny that Annunciation Day was also the day of the Resurrection, that our Lord arose to sit in our Lady's lap.

With regard to the date of the Crucifixion two points are certain:

1. Christ was crucified while Pontius Pilate was governor of Judea, i.e., between the summer of A.D. 27 and the spring of A.D. 37;
2. The day of the Crucifixion was a Friday.

Not so certain, though coming to be accepted by most students of Scripture, is:

3. Christ was crucified on the day on which the Jews eat the Paschal Lamb. This third point is indicated by St. John (13:1; 18:28; 19:31). Now, the Jews eat the Paschal Lamb on the night of the first fourteenth day of the moon after the spring equinox, which was known to the Jews as Nisan 14, or the fourteenth day of the month of Nisan.

Therefore, our three points lead to the conclusion that the Crucifixion took place on Friday, Nisan 14, between the summer of 27 and the spring of A.D. 37. But Nisan 14 was a Friday only twice between the summer of 27 and the spring of 37, namely on April 7, 30, and April 3, 33. To choose between these dates, we have first to determine something about the date of our Lord's baptism. St. Luke (3:1) gives the date of the beginning of the Baptist's mission as: "in the fifteenth year of the reign of the Emperor Tiberius." St. Luke was a Syrian; the Syrians reckoned the years of Tiberius from October 1, A.D. 14. If St. Luke calculated according to the Syrian method, "the fifteenth year of Tiberius" would mean between October 1, 28, and October 1, 29. If the Baptist did not start his mission before October of the year 28, the first Pasch mentioned by St. John (2:13–23) could not have been earlier than spring, 29, and the

third could not have been earlier than A.D. 31; thus the year 30, as the year of the Crucifixion would be ruled out. If St. Luke, the Syrian, did not calculate according to the Syrian method, then the year 30 would not be so easily eliminated. Kepler's and Father Deckers' choice of the year 31 is inadmissible so long as we hold that the day of the Crucifixion was Friday, Nisan 14; for Nisan 14 was not a Friday in the year 31. Nisan 14, 31, was either Saturday, March 24, or Sunday, March 25, or Tuesday, March 27, according as we reckon from the Christian calendar, the time of the astronomical new moon, or the probable first appearance of the new moon at sunset.

In 1612 there appeared at Frankfort Röslin's *The Precursor of Chronological Dissertations.* It was dedicated to the Emperor Matthias, who had been elected that year. The author explained that it was dedicated to the Emperor because, among other reasons, it was largely "a refutation of the false opinions of His Majesty's Mathematician Johann Kepler about the year of our Lord's birth." Kepler replied, in 1613, with a book written in the vernacular known briefly as *Bericht vom Geburtsjahr Christi.* It contained the theories of his *Chronological Forest* as crystallized from correspondence with Calvisius and Deckers. The title of the book was not brief; it told its purpose, namely, to defend that Christ was not born in 2 B.C. as Röslin and Bunting would have it, nor in 3 B.C. as Scaliger and Calvisius maintained, but in 6 B.C. Calvisius had made his name as a classical and mathematical scholar almost before Kepler was born. Declining professorships of mathematics at Frankfort and Wittenberg, because he wished to have time to devote to music, he agreed to conduct the school of music at Leipzig. Having the temperament of a musician, he was furious when he saw his name flashed on the front page of a book by Kepler. He wrote and published an open letter to Kepler: *A Letter of Seth Calvisius about the True Year of the Birth of Christ to the Eminent and Excellent Astronomer Johann Kepler, His Majesty's Mathematician, who, contrary to the express words of the Evangelist Luke, attributes 33 years of age to Christ at the Time of His Baptism.* Kepler replied in kind; he published his: *Reply of*

Johann Kepler, the Mathematician, to the Letter of Seth Calvisius, in which the Crime of Perverting the Sense of the Words of the Evangelist is Retorted. The announcement of this reply was the cause of Father Deckers breaking his seven-year silence. On May 22, 1614, he wrote to Kepler, who was now residing at Linz:

> Eminent Sir. The Peace of Christ to you. Pardon, pardon, I pray and beseech, the long neglect of my duty of writing, which I dare to resume, unimpeded by shame. My long journey to Italy, and my migration and yours, and most serious business necessitated my silence. Though I showed no sign of life by letter, my friendly feelings and affection were not dead. Now my hand has been moved, and the pen put in my hand, by your *Reply to the Letter of Calvisius,* of which I have recently learned, with pleasure, from the catalogues of the Frankfort markets. Nor was there anything for which I so desired or keenly wished than to scrutinize it with my own eyes and mind, and diligently to ponder it. But my affections have been exquisitely tortured, for, so far, I have not been able to obtain a copy of your *Reply;* nor have I been able to obtain a copy of Isaac Casaubon's commentary on the *Apparatus* of Baronius' *Annals,* about the years of the death and birth of Christ, although I have gone to the trouble of enquiring at Augsburg and Vienna and various other places, and even at Antwerp; a copy cannot be had either for love or money. . . . If you believe it to be to the profit of our common studies, will you give a copy to some one of Ours of Linz College, so that it can be sent to me at Graz, to where I have, at last, returned again to my former job of Chancellor of studies. If, in turn, you have any need of my assistance, there is nothing which I will not do just as willingly. Your Lordship's servant in Christ, J. Deckers.

We do not have Kepler's reply: but from Father Deckers' acknowledgment we gather that Kepler regretted that he had only one copy of his *Reply,* with which, of course, he did not wish to part. But, he told Father Deckers, he had completed a whole book which would be against Calvisius; and he also took the occasion to inform him that he was putting out a *Selection of Letters* on chronology, which would include Deckers' letters to him. In fact, he had decided on doing this as early as 1611,

and had that year obtained Herwart's permission to include his letters. He had completed the compilation of letters in April, 1612; the troublesome times delayed their publication; they were actually in the hands of the printer when he informed Deckers. He does not seem to have told all that to Father Deckers, who wrote on September 22, 1614:

> Eminent and Illustrious Sir. The Peace of Christ to you. It was only yesterday, here at Vienna, that I received your letter of September 3, a most acceptable letter, as yours always are. I was sorry to learn how late mine was in reaching you. . . . I was eagerly hoping for a copy of your letter to Calvisius; but, since you have only the one copy yourself, I would indeed be importunate if I endeavoured to extort it from you, although I would be satisfied to see a copy, and look through it hurriedly. I shall look forward with equal desire and longing to your other thing against Calvisius and your *Selection of Letters*. . . . I am compelled to cut short my letter, as Ours are in a hurry to leave for Linz. More later. Please give your letters to one of Ours. Your Lordship's servant in Christ, J. Deckers.

The "other thing against Calvisius" was Kepler's definitive work on the date of the birth of Christ. He had it finished on March 25, 1614, but it was not off the press until December. It bore the title: *On the True Year in which the Eternal Son of God assumed Human Nature in the Womb of the Blessed Virgin Mary*. It was little more than a Latin translation of his *Bericht vom Geburtsjahr Christi,* with answers to Calvisius' objections inserted, and direct references to Röslin omitted. Two hundred years later, Dr. Ludwig Ideler voiced the opinion that this work of Kepler left posterity little to add on the main issue, namely, on the year of the birth of Christ. Three hundred years later, we may say at least that Kepler did his job with German thoroughness — it took many diggings of archeologists to add unconsidered evidence. To say that the question was settled by him is another matter. Kepler's *True Year* is now of historical interest only. Interest in it does not lie in the main issue, but in a side issue. It contains Kepler's theory about the Star of Bethlehem in its final form, and the theory is typically Keplerian — born of erudition wedded to astrology by misguided genius.

> I follow those who estimate that when Herod inquired of the Magi the time of the star, two years had already elapsed since its first appearance. You ask, why then should they have come now at last to adore the King announced by the star? Because this star was not of the ordinary run of comets or new stars, but by a special miracle moved in the lower layer of the atmosphere. . . . The Magi were of Chaldea, where was born astrology, of which this is a dictum: Great conjunctions of planets in cardinal points, especially in the equinoctial points of Aries and Libra, signify a universal change of affairs; and a cometary star appearing at the same time tells of the rise of a king. . . . Granted, then, that the new star was first seen not only at the same time as Saturn and Jupiter were beheld each in the other's vicinity, namely in June 7 B.C., but also in the same part of the sky as the planets (as most wonderously happened in our own time, with the new star in the Archer), what else could the Chaldeans conclude from their, and the still existing, rules of their art, but that some event of the greatest moment was imminent? But from this time, namely from June of the year 7 B.C., to February of the year 5 B.C., is two years, less four or five months. There is not anything, therefore, which an astrologer could oppose to my computation of the year of the birth; and he has reason to make much of the year 6 B.C., and to think it most fitting for the birth of Christ and the star of the Magi.

Kepler's *Selection of Letters* was published at Frankfort in 1615. The letters are all on chronology. There are eight letters from Calvisius, with Kepler's replies. These are followed by a letter from Kepler to Gerstenberger. Gerstenberger had written to Kepler in 1609, requesting an explanation of the chronology of Calvisius; this gave Kepler an opportunity to write a summary of how and why he differed from Calvisius. The correspondence with, and about, Calvisius, is followed by Father Deckers' four letters of 1607, with Kepler's replies. Then there are eight letters from Herwart, to which Kepler replied with five. The names of the correspondents are concealed, thinly, except Calvisius'. Herwart is referred to as "J.G.H.," Deckers as "J.D.," and Gerstenberger as "Jon. Gerts." The last mentioned was effective concealment, because Gerstenberger's Christian name was Marc. The *Selection of Letters* ended with: "An

Extract from the Spanish Jesuit Juan Mariana." The extract was to the point inasmuch as Mariana endeavored to show that Christ died on March 25. Kepler did not acknowledge the source of the excerpt. It was, in fact, from a book published at Cologne in 1609, entitled *Seven Treatises of Juan Mariana of the Society of Jesus,* the fifth of which was *On the Day of the Death of Christ.*

It would be strange if Kepler did not send a copy of his *Selection of Letters* to Father Deckers; but if he did, we have no record of the fact; we have no letters between Kepler and Deckers later than 1614. The publication of his earlier letters may have done Father Deckers harm. He was already having difficulties with the powers that be. His theses defended by Suslyga were a trial balloon, being the forerunner of a more comprehensive chronology of the life of Christ. By 1612, he had ready for printing his three-volume treatise. If he had been working on it since 1584 (the year in which he started studying theology), he had been working on it for 28 years. It failed to pass the deputed censors. Father Deckers' resignation to the futility of what was practically his life's work won for him the admiration of all who knew of his disappointment. But what Father Deckers took placidly, others did not. After he went down to his grave, in January, 1619, appeals went to Rome to have his work published. In 1624, the Archduke Charles appealed to Rome, but Rome was adamant. When last heard of, Deckers' manuscript was still gathering dust – one copy at Graz, and another at Louvain. It earned for Father Deckers a lasting encomium, more edifying than accurate, which for its former quality is worth recording:

> At Graz, in Styria, in the year 1619 died Father John Decker (*sic*), a Belgian. In his last agony he said softly: "Come, Lord Jesus, come." Then pausing a moment, he added: "I come"; and so departed. A man illustrious no less for his perfect life in Religion than for his great learning. He used to fast from the eve of Maundy Thursday to Easter Sunday at noon. His noble chronological work of three folios was the work of forty years; and when some asked for its publication, and others thought it should be suppressed, he said he would throw it into the fire without being at all disquieted, if Superiors desired it. Father John was the first to employ the method of teaching philosophy and theology which is now adopted everywhere as most convenient in the schools.*

* *Menology of the Society of Jesus,* Roehampton, 1874, 11.

CHAPTER V

THE TELESCOPE

In Kepler's life the event of the year 1609 was the appearance of his long promised, and not yet forgotten, *New Astronomy . . . with a Commentary on the Motion of Mars.* All the laudatory epithets that may be justly applied to this work have long since been exhausted — it is unnecessary to rehearse them. The book, of course, is most noticeable for the enunciation of Kepler's first two laws of planetary motion. The full credit for the discovery of these laws must be given to Kepler. At the same time it is well to recall that no one had ever had the opportunity to discover them which he had. He had the observations of Brahe, extending over more than twenty years, and made with the most accurate instruments that man had ever used to search the heavens. Kepler was neither unmindful nor forgetful of the debt he owed to Brahe — on the title page of his *New Astronomy* he had printed: "Elaborated by Johann Kepler from observations by Tycho Brahe." Nor did he forget Copernicus — on the back of the title page he announced that he had evidence that Copernicus held his system as representing fact, and not merely as a useful hypothesis, as was generally believed.

In the introduction to the *New Astronomy,* a number of axioms relating to gravity are enunciated, and we are told that "the tractive force" of the moon reaches as far the the earth and produces tides. Kepler defined gravity as a mutual attraction similar to magnetic force. But when he came to seek the explanation of his laws, he failed to see that this attraction was identical with the force which keeps the planets in their orbits.

The first of the planetary laws which Kepler discovered was the *Law of Equal Areas.* According to this law, *the continuously varying velocity of a planet in its orbit is such that the straight*

line from the planet to the sun sweeps over equal areas in equal intervals of time. Kepler discovered his law of equal areas first for the earth, and applied it to the other planets later. When he deduced it for the earth, he was of the opinion that the orbits of the planets were circles, with the sun not far from their centers. The orbit of the earth is so nearly a circle that he discovered his law, in spite of his false opinion. But when he came to apply his law to the orbit of Mars, he found it did not hold. He was so convinced that it was a universal law, true for all the planets, that he tried to make the orbit of Mars fit his law, and so discovered his second law, and the falsity of one of his first assumptions. His second law, the *Law of Elliptical Orbits,* is: *The orbit of each of the planets is an ellipse with the sun at one of its foci.*

Kepler did not discover his second law by intuition; far from it. When he found that his first law would not apply to Mars, if the orbit of Mars was a circle, he concluded that the orbit of Mars was not a circle but an oval. To find his "equal areas" for an oval was not easy, because an oval, like the cross section of an egg, is narrower at one end than at the other. To find the area of an oval sector, he divided it into a series of smaller sectors, and considered each small sector to be, approximately, the sector of some ellipse; but he never thought of the orbit being an ellipse. Even after he found that the true orbit lay between the circle and the oval, he did not think of it as an ellipse. He made his discovery the hard way; after a tedious tabulation of Brahe's observations of Mars, and a still more tedious investigation of the locus of Mars, he proved, geometrically, that this locus was an ellipse.

To understand why Kepler was so slow in thinking of elliptical orbits, we must remember that the principle of circular motion had, from the earliest times, been considered self-evident, and so had never been called in question. Kepler's announcement of elliptical motion was revolutionary. But all Kepler did was to announce *how* the planets moved; the question *why* naturally arose — it leaped to Kepler's mind, as it did to all inquiring minds. Kepler had an answer, though not the

true one – it was left to Newton to find that. Force, said Kepler, emanates from the sun in straight lines, in one plane, like the spokes of a wheel. As the sun rotates, the lines of force whirl round, and cause a vortex in the ether, which carries the planets with it. The rate of motion varies with the planet's mass. But why elliptical motion? Kepler's answer to this was that the planets are "huge round magnets." One of the magnetic poles of a planet seeks the sun, while the other is repelled by it. During the planet's journey around the sun, first one magnetic pole is near the sun, then the other. Consequently, the magnetic force is at one time tending to draw the planet toward the sun, and at another tending to repel it; hence the elliptical orbit. The shape of the orbit, that is the flatness of the ellipse, is different for different planets, because the intensity of magnetism is different for different planets. That planets are magnets, Kepler "proved" by a fallacious argument. The earth, he said, is a magnet, and the earth is a planet, therefore, planets are magnets. To justify his major, that the earth is a magnet, he referred to William Gilbert's book on the magnet (published in 1600). The minor, that the earth is a planet, he took to have been proved by Copernicus.

Kepler's laws have made celestial mechanics what it is today. Inasmuch as they sowed the seed for Newton's work, they were the greatest contribution to physical science in sixteen centuries. But their announcement was overshadowed by a more spectacular discovery. In the same year, 1609, in which theoretical astronomy was revolutionized, a new era in observational astronomy opened with startling suddenness. A telescope was turned to the sky, and the professor of mathematics at the University of Padua saw the skies as no man had ever seen them.

The story of Galileo's "invention" is best told in his own words. Writing to his brother-in-law, Beneddeto Landucci, August 29, 1609, he said:

> Two months ago a report spread here that in Flanders an eyeglass had been presented to Prince Maurice, constructed in such a way as to make distant objects appear quite near, so that a man two miles away could be been distinctly. So marvelous an achievement set me wondering. As it appeared to have some foundation in the science of perspective, I began to think how to make such a glass. At length I found out, and have succeeded so well that the one I have made is far superior to the Flemish one.
>
> As the news reached Venice that I had made such an instrument, I was, a week ago, summoned to show it to His Serenity, and exhibited it to him and to the whole Senate, much to his amazement. Many noblemen and senators, even the oldest, ascended the highest towers in Venice, to spy out ships at sea making for the mouth of the harbour, and saw them clearly, though without my glass they would not have been visible for two hours more; for the effect of my instrument is to show an object fifty miles off, as it were but five miles away.

With the aid of his marvelous instrument Galileo, on the evening of January 7, 1610, discovered the satellites of Jupiter, and thirteen days later wrote to Vinta, secretary to the Grand Duke of Tuscany:

> I am at present staying at Venice for the purpose of getting printed some observations which I have been making by means of one of my glasses. And being infinitely amazed, so did I give infinite thanks to God who has been pleased to make me the first observer of marvelous things, unrevealed to bygone ages. I had already ascertained that the moon was a body very like the earth, and had shown our Most Serene Master as much, but imperfectly, not having such an excellent glass as I now have, which besides showing me the moon, has revealed to me a multitude of fixed stars never seen before – being more than ten times the number of those that can be seen with the naked eye.
>
> Moreover, I have ascertained what has always been a matter of controversy among the philosophers, namely, the nature of the Milky Way. But the greatest wonder of all is the discovery I have made of four new planets; I have observed their own motions and their motions relative to one another, and how they differ in motion from all the other stars. And these new planets move round another very great star, in the same way as Venus and Mercury, and perhaps the other planets, move around the sun.
>
> As soon as my treatise is printed, I intend sending it to every philosopher and mathematician. I shall send a copy to His Serenity the Grand Duke, together with a first-class glass,

which will enable him to judge for himself the truth of these discoveries.

The narration of Galileo's observations was published at Venice in March, 1610, under the title *The Sidereal Messenger.* Before copies of this historic book had reached Prague, Kepler heard of it and of its contents. He tells us that about the Ides of March Matthew Wackher of Wackhenfels, Councilor to the Emperor Rudolph II, stopped his carriage at the door to tell him of the new discoveries. "So great," writes Kepler, "was my wonder at this most absurd delightful news, and so great my excitement (for it was an unexpected decision of a little dispute which we had had), that between his joy and my confusion, and the laughter of us both, confounded as we were by the novelty, that he was scarcely able to tell his story, or I to listen."

The next courier from Italy brought a copy of Galileo's *Messenger* to the Emperor at Prague. Kepler had an opportunity to glance through it. On April 13 he received his own copy from Julian de Medici, the Tuscan ambassador at Prague. Kepler lost no time in writing a splendid commentary on it. He had never seen a telescope, but he argued for the intrinsic possibility of Galileo's discoveries. His commentary was finished by April 19, and dedicated to Julian de Medici, with a letter dated May 3, 1610. It was published with the title: *A Talk with the Sidereal Messenger lately sent by Galileo to Mortals.*

Galileo's discoveries became the talk of princes and people. In his home town of Florence there was great excitement. Everybody wanted to have "a Venetian glass." Alessandro Sertini received a parcel from Venice; the word went round; friends came trooping in; was it a telescope? It was not; it was only a copy of *The Sidereal Messenger;* but even that was something. Sertini was invited to a party, and from the *Messenger* he read for the guests the bit about the "planets" going round Jupiter.

Galileo had conceived the idea of naming the newly discovered satellites of Jupiter after the Grand Duke Cosmo. His first thought was to call them *The Cosmeans;* his second thought was brighter. There were four satellites; he called them *The*

Medicean Stars, and the Grand Duke and his three brothers were all flattered. Other royal personages were not a little jealous. A bare three weeks before the assassination of Henry IV, "a valued servant of his Majesty of France" wrote to Galileo:

> The second request, and the most pressing, is that when you discover some other beautiful star, you call it by the name of the great Star of France, by far the brightest in all the earth, and rather by the name Henry than Bourbon, please. By so doing you will do the most correct, just, and proper thing; you will gain renown and, also, lasting riches for yourself and for your family. Of this I can assure you on my honour. Therefore, discover, as soon as possible, some heavenly body to which His Majesty's name may be fitly attached.

Among those who received copies of the *Messenger* was Ernest, Archbishop and Elector of Cologne. Ernest did not find it all for which he had hoped. He wrote to Italy that Galileo might have included in it instructions for making a telescope. Michael Angelo Galilei relayed the criticism to his brother, Galileo Galilei, and pleaded with him: "See if you cannot gratify the Elector by showing him how to manufacture the instrument, or else write him a letter in your own way." Galileo did not send the Elector instructions; he did better — he made him a telescope. The telescope arrived at an opportune time. At the end of 1609 the discord between the Emperor Rudolph and his brother Matthias still persisted. Pope Paul V suggested a meeting of all the Archdukes to iron out outstanding points of disagreement. He charged the Elector of Cologne with the task of urging the Emperor to agree. Before the Elector left for Prague, Herwart commended Kepler to his benevolence. The commendation bore fruit when the assembly of Princes came together in September, 1610. The Elector then had his telescope, and he had it with him. He lent it to Kepler while he himself was busy with the affairs of State. For eleven days, August 30 to September 9, Kepler became a searcher of the skies. Two days later he had finished writing a report of what he had seen. The story he had to tell took about 2500 words,

and concluded: "These observations having been made, and the truth of Galilei's account sufficiently confirmed, and since it was thought that the Elector would soon be returning, the instrument was returned." The report was published the following year as *Johann Kepler's Narration of his Observations of the Four Wandering Satellites of Jupiter.*

With the telescope off his hands, Kepler had time to complete his *Dioptrics.* In his *Optics,* in 1604, he had explained his theory of ocular vision; the *Dioptrics* was to explain vision through lenses. He handed a copy of it to the Elector of Cologne before he left Prague in September, 1610. The following spring he published it, together with a dedicatory letter to the Elector, dated January 1, 1611. He had, meanwhile, added a preface on the use of the telescope and of the recent discoveries made by it. This preface included three letters from Galileo to Julian de Medici, dated, from Florence, November 13, 1610, December 11, 1610, and March 26, 1611. In the second of these Galileo disclosed his discovery of the phases of Venus, and in the first that Saturn "consisted of three stars." Galileo was certain that Saturn was a triple star – he was always sure of his judgments. A sober conspectus of what the findings of the telescope really were is contained in the reply to a letter which Cardinal Bellarmine addressed to Father Clavius and his associates at the Roman College on April 9, 1611. Cardinal Bellarmine wrote:

> I know that your Reverences have heard of the new astronomical discoveries which an eminent mathematician has made by means of an instrument called a *cannone* or spy-glass. I myself with the aid of the instrument have had some very wonderful views of the Moon and Venus, and I would be grateful if you would favour me with your candid opinion on the following points:
>
> 1. Whether you confirm the report that there are multitudes of fixed stars invisible to the naked eye, and especially whether the Milky Way and nebulae are to be regarded as congeries of very small stars.
>
> 2. Whether it is true that Saturn is not a simple star, but three stars joined together.

> 3. Whether it is a fact that Venus changes its shape, waxing and waning like the moon.
>
> 4. Whether the moon really has a rough and unequal surface.
>
> 5. Whether it is true that four mobile stars revolve round Jupiter, each with a different motion from that of the others, but all the motions being exceedingly swift.
>
> I am anxious to have some definite information about these matters, because I hear conflicting opinions expressed with regard to them. As your Reverences are skilled in the science of mathematics, you will easily be able to tell me whether these new discoveries are well-founded, or whether they may not be a mere illusion.

The reply was precise and accurate. Summarized, it said:

> 1. It is true that the telescope reveals a vast number of stars in the nebulae of Cancer and the Pleiades, but it is not so certain that the Milky Way consists only of small stars.
>
> 2. Saturn appears oval and oblong, in this manner: oOo, though we have not seen the two stars at the side detached from the center one in such way that we could call them separate stars.
>
> 3. It is perfectly true that Venus waxes and wanes like the moon.
>
> 4. Father Clavius thinks that the great irregularities and inequalities on the surface of the moon are merely apparent; the others are of opinion that the surface of the moon is really rough; but so far there is not sufficient evidence to be positive.
>
> 5. It is true that four stars may be seen revolving round Jupiter with great rapidity, each with a different motion. They cannot be fixed stars.

This clear statement was signed by the Jesuit Fathers Christopher Clavius, Christopher Grienberger, Odon van Maelcote, and Giovanni Lembo. Father Maelcote we shall meet again as an ardent admirer of Kepler's works; but, before him there was another Jesuit, Father Christopher Scheiner, who was to profit by the reading of Kepler's latest work, his *Dioptrics.*

The main argument of the *Dioptrics* consists of 141 numbered assertions, comprising definitions, axioms, problems, and propositions. Starting with the simplest examples of refraction, Kepler leads up to the theory of the Galilean telescope, which

had a convex lens as object glass and a concave lens as eyepiece. In the building of his theory, he considered the possibility of using a convex eyepiece with a convex object glass; he showed that with this arrangement, on looking through the eyepiece, one would see an inverted image of the distant object. He did not advocate the making of telescopes with convex lenses; a telescope was something into which one could look, and see distant objects as they were.

The proud possessors of telescopes used them as toys by day, and as instruments by night. The great Galileo delighted in entertaining his friends with the telescope; they could watch incoming ships, and read the inscriptions on distant basilicas. Father Scheiner, professor of mathematics at Ingolstadt, had no taste for toys. His telescope was an instrument by day and by night. To use it by day he devised various means of studying the sun, even when at its brightest. He used filters, through which he could look at the sun directly; and, without filters, he cast the image of the sun on paper behind the telescope. He did this latter with his Galilean telescope; and the image on the paper was inverted. Then he remembered Kepler's remarks on the convex lens; one could get an upright image on paper by using a convex eyepiece. He built a telescope with two convex lenses. He used it not only to cast images on paper, he also looked into it, and found he had a better telescope. He "looked into it" — one does not look through a telescope, but into it. The object glass of a refracting telescope forms an image in the tube of the telescope; this image is examined by looking through the eyepiece; the eyepiece is a magnifying glass, or miniature microscope; through it an enlargement of the image in the tube can be seen. A convex lens, used as eyepiece, gives a clearer enlargement than a concave lens of the same power; and a convex eyepiece of greater power still gives a clear enlargement; but, with a convex eyepiece, the object viewed appears inverted. Father Scheiner found that the sun looked just as well upside down as right side up. It was not until the year 1630 that he told the world of his telescope with two convex lenses; thereafter this Scheiner telescope became the model

for all astronomical telescopes. With the aid of his simple astronomical telescope, Father Scheiner became, in the words of Costard, "the most exact observer of spots in the Sun."*

Sunspots were discovered in March, 1611. Kepler did not hear of them for many months, and then he was only mildly interested. There were other things to occupy his mind — so many others that he "completely forgot astronomy." Of the fatal year 1611 he wrote, in 1615, to his friend Crüger, apologizing for not having written for years:

> The terrible year of 1611 was depressing from every angle. My salary was not forthcoming from the Imperial Treasury. My wife, who had been so highly esteemed by all, fell a prey to despondent melancholy, and finally, at the end of the year 1610, became seriously ill with Hungarian fever, epilepsy and fits. She had scarcely recovered, when, at the end of January, 1611, my three children went down, all together, with serious attacks of smallpox. Meanwhile Leopold occupied the part of the city across the river with his army, just at the same time as the dearest of my sons died, he of whose birth you will find mention in the book about the New Star. The other side of the city, where I then lived, was infested with the Bohemian army, a noisy, threatening crowd, swelled by recruits from the country. Then came the Austrian army. Therefore I went to Austria, to see about obtaining the place which I now have. Returning in the month of June, I found my wife, who had been wasting away with pining for her lost child, now in the last stages of a contagious fever, and eleven days after my return I lost her.

The *Kleinseite* of Prague was occupied in February, 1611, by the Passau troops under Archduke Leopold, who hoped to strengthen the Emperor's hand. The move was foreseen, and the Bohemian Estates had levied an army which seized the *Altstadt,* or old part of Prague, where Kepler lived. As Kepler told another correspondent, there was bloodshed in the streets when the Bohemian army moved in, and a savage riot after the soldiers were installed. Four monasteries were sacked and fifteen Franciscans murdered. The Austrian army, says Kepler, brought

* *The History of Astronomy,* by George Costard (London, 1767), p. 182.

disease with them. They were led by Matthias, who made his solemn entry into Prague on March 24, and received the crown of Bohemia from Rudolph on May 23. In the aftermath, Tengnagel, Tycho Brahe's son-in-law, was thrown into prison on the charge of treason, having assisted Leopold; he was later released through the intervention of the Spanish ambassador. Toward the end of May, Kepler set out for Linz to feather a new nest for himself. He offered himself to the Estates of Upper Austria as Provincial Mathematician; but the Emperor would not hear, either of his resigning as Imperial Mathematician, or of his residing at Linz. Rudolph died on January 20, 1612. During the interregnum Kepler obtained permission to reside at Linz. After his election to the Imperial Throne, on June 13, 1612, Matthias confirmed the permission granted. Ever since his experiences in 1608, Kepler had been longing to leave Prague — the center of a tottering Empire was no place for quiet studies.

CHAPTER VI

SUNSPOTS

In March, 1611, Father Scheiner was using the telescope to study the sun from the tower of the church at Ingolstadt, when he thought he saw spots on it. Father Scheiner, at this time, was a young priest, and unknown. He had taken over the chair of mathematics at Ingolstadt only the previous fall; and had every reason to hesitate about telling the Aristotelians of his faculty that the sun was mottled — if it was. He would wait and see what he would see. It was not until the following October that he was sure of himself, and showed the spots on the sun to some of his confrères, who counseled him to announce his discovery to the world. But his major superior, the sixty-four-year-old Father Buys, who had not faired so well at the hands of Mästlin twenty-five years before, advised him not to rush into print unless he was sure of his facts; and even then to use a pseudonym, for ridicule would be poured on his head when he claimed to have seen things in the sun!

Scheiner was sure of his facts. He wrote three letters describing what he had seen, and defending his thesis that the spots were on the sun. But in sending the letters to Marc Welser, a historian at Augsburg, he asked him to publish them as written by "Apelles hiding behind the tablet." The pseudonym was a proud challenge, for it as much as said that the author could prove his authorship by his mastery of the subject. Apelles, the most celebrated of Greek painters, on one occasion called to see his friend Protogenes. Protogenes was not at home; to indicate that he had been there Apelles took a paint brush and drew an exceedingly fine line on a prepared tablet. Protogenes returned, and understood — nobody but Apelles could have drawn that line. Not to be outdone, he dipped his brush in

paint of another color and drew a finer line on top of that of Apelles. Apelles came again: down through the middle of Protogenes' line he drew a still finer line, and was confessed the victor.

Scheiner's letters appeared as *Three Letters about Solar Spots written to Marc Welser of Augsburg*. The first letter was dated November 12, 1611, and related the facts which he had observed. He had noticed that the spots were visible for about twelve days, and moved as though the sun was rotating. During the two months of observation the same spots did not reappear, but others appeared about fifteen days after the previous ones had disappeared. Later, he corrected this and said that the same spots did reappear but in changed form, as they were continually changing shape. The spots were visible for twelve days and invisible for fifteen days, because only four fifths of the sun's surface – neither its back nor sides – could be seen. The sun, he estimated, took twenty-seven days to rotate. In the second letter he excluded the possibility of the spots being "Venus in the sun"; and in the third, dated November 26, 1611, he had excellent arguments to show that the spots were not comets or satellites or any other bodies at a distance from the sun. Welser received them from the printer January 5, 1612, and the following day sent a copy to Galileo.

Kepler first heard about sunspots from Wackher, who had also been the first to tell him of the discovery of the satellites of Jupiter. Wackher lent Kepler a copy of Scheiner's *Three Letters,* and asked him to write what he thought of them. Kepler's letter to Wackher is not dated; but its internal evidence testifies that it must have been written very shortly after the publication of Scheiner's work, since it shows that it was written before Kepler had seen any other book on sunspots, and the day after Wackher gave him Scheiner's. Kepler was very curious to know who the author was – Wackher had guessed Brengger; Kepler suggested Welser himself, or John Bayer. "No matter who he is," he said, "we must now believe not vain was the promise of that John Fabricius who, in the indexed catalogue, promised us sunspots at a forthcoming market. And slothful us

at Prague who with Leipzig not far away, have not even yet a copy of this book." Coming to his promised criticism, he says:

> The first of Apelles' letters leaves no doubt in my mind that there is no question of an illusion produced by the telescope. Whoever he is, he speaks as a mathematician, reasons soberly, is aware of illusions, and has taken the greatest precautions. Therefore, the truth of his facts I entirely concede; those things over and above the facts, which he discusses and proposes, it is a pleasure to discuss.

In his discussion of the first letter, Kepler argued that he could not conclude from Apelles' observations that the spots were on the surface of the sun. His argumentation of this point was, in one respect, unsound and ill befitting the Imperial Astronomer. "I see," he wrote, "that the spots cross the disk of the sun in about twelve days. Therefore, if we suppose that they spend another twelve days on the other hemisphere of the sun, after twenty-four days we should have the same view of the same spots." He overlooked the fact that when we see a distant sphere we do not see a hemisphere, but less than a hemisphere; if spots on the surface of the sun are visible for twelve days, they must be invisible for about fifteen days, if the sun rotates.

Kepler made an attempt to verify Apelles' discoveries; it was a rash attempt, betraying the fact that he knew nothing of the technique of observing the sun with a telescope. "This morning," he wrote, "I turned a telescope to the sun. . . . For scarcely the twinkling of an eye could I bear the brightness of the sun." If he had had a more powerful telescope, he would have burned his eye out; as it was, he could not write for an hour afterward.

In his second letter, Apelles ruled out the possibility of the spots being nothing but Venus transiting the sun. Such transits were impossible according to Ptolemy, who introduced such librations in the epicycle of Venus that the planet was always off the sun at the time of conjunction. And, if Venus did transit the sun, it would not take twelve days to do it. According to Copernicus' planetary theory, Venus should have transited the sun nine times between 1579 and 1611; none of these transits had been observed, said Apelles. From which, said Kepler,

nothing follows except that Copernicus' system was faulty (as Kepler had already shown in his *New Astronomy*).

The third letter stressed the fact that the same spots did not seem to reappear, and inclined toward the opinion that the seeming spots were dark objects circling close to the sun. This theory pleased Kepler immensely, but like Apelles he left the question open, for the moment: "With him I conclude that that which we know is insignificant compared with that which we don't know." He signed the letter: "The Cobbler criticizing Apelles' Tablet," a pseudonym as apt as it was humble – Apelles was the originator of the now proverbial phrase: "Cobbler, stick to your last!" There was a postscript to Kepler's letter: "Just look! At this opportune moment comes Fabricius testifying to spots on the sun! You will see, if you survive the tedium of labyrinthine pools of words, a confirmation not to be contemned." The letter was written at Prague, probably in January, 1612, and certainly not later than May, 1612, when Kepler moved to Linz. Written to Wackher, who lived in Prague, and whom Kepler saw every other day, it was illustrated by a diagram and was signed with a pseudonym. Though probably intended for publication, it was never published. The Emperor Rudolph died on January 20, and for some months, both Kepler and Wackher were more concerned about bread and butter than about sunspots.

Johann Fabricius, whom Kepler mentions in his letter to Wackher, was the son of David Fabricius, and was then in his early twenties. His book, which reached Prague after Father Scheiner's, was entitled: *Johann Fabricius' Narrative about Spots in the Sun, and their apparent Turning with the Sun.* Published in Wittenberg with a dedicatory letter dated June 13, 1611, it has the best claim to be called the first public announcement of the discovery of sunspots. Three years before, Kepler had corresponded with its youthful author; and for eight years he had corresponded with his father. But he took no notice of the book, and did not write to congratulate either father or son.

In September, 1612, Father Scheiner's second book, *A More Accurate Disquisition about Solar Spots and the Stars wandering round Jupiter, written to M. Welser,* was off the press at Augsburg. Just before reading this latest lucubration, Kepler wrote to Simon Marius that he himself had been observing sunspots that year. "I believe," he wrote, "that they are the solar equivalent of terrestrial clouds, driven from the surface of the scorching sun by its own heat, and are, perhaps, of the same materials as comets, which are, perhaps, produced by the sun." Welser sent Scheiner's *Disquisition* to Kepler on November 1, 1612. The *Disquisition,* consisted of three letters, dated January 16, April 14, and July 25, 1612. They were, again, from "Apelles." They defended the opinion that the spots were on the surface of the sun. With them, Welser sent to Kepler this covering note: "I send, as you see, my letters from Apelles, about which if you choose to express an opinion, at your convenience, you will do me a great favor. As far as I am concerned I most willingly give you all that is in my power – to use them or abuse them."

Kepler did not abuse them; he used them only for an observation of the lunar eclipse of May 12, 1612, recorded in the last of them. There was reason why Kepler had to rely on another's observation of this eclipse. He was changing his residence from Prague to Linz in May, 1612. He went by way of Vienna. The night of the eclipse he was in a small town in Moravia, where it thundered and rained. As regards Apelles and his sunspots he had nothing to say. Welser was wishing Kepler would write something. Welser was gaining reflected glory by the discovery of sunspots; if Kepler would write to him, it would be so much more. Kepler had neither the time nor the taste for writing another disquisition, such as he had written to Wackher. In July, 1613, Welser came back with another bait to tempt him to write. He sent Kepler Galileo's *Story and Proof of Sunspots* (Rome, 1613), and in an accompanying letter wrote: "Since Galileo has replied at length to Apelles' letters, and seems to come closer to your opinion about sunspots than to that of Apelles, I thought that a copy of his work should be certainly sent to you." Galileo replied to Apelles' *Three Letters*

of 1611 in the form of three letters to Welser; his reply formed part of his *Story*. Kepler received Galileo's *Story* on July 18, 1613. Before wading through its Italian, which he did not enjoy reading, he wrote to Father Odon van Maelcote, a letter which is his second longest piece on sunspots. Before quoting it, Father Maelcote must be introduced.

Writing from Rome on July 23, 1611, a Jesuit Scholastic, Gregory of Saint Vincent, tells of a great reception given in the Roman College to Galileo. The organizer of the reception was Father Clavius, the principal speaker for the hosts was Father Maelcote. Father Maelcote delivered an enthusiastic discourse on the new astronomical discoveries. Seventeen months later, he was in Brussels, writing to Kepler. His name was probably known to Kepler as the author of *The Equinoctial Astrolabe* (Brussels, 1607). He was also the author of *The Sidereal Messenger of the Roman College,* which is reproduced in Galileo's works. He approached Kepler through a mutual friend, Herr Schiller. To Schiller he wrote that he had four of Kepler's books, *New Astronomy, A Talk with the Sidereal Messenger, Dioptrics,* and *On Snowflakes,* and would like to have copies of his others, two of each if possible. Would Schiller ask Kepler what he thought of sunspots? Also, what does he think of Francesco Piffaro's catalogue of those fixed stars which Brahe omitted from his catalogue, and which Father Grienberger compared with Ptolemy's? He enclosed a letter for Kepler himself, asking him to answer Schiller's questions, who would then write him. He took care to render Kepler benevolent, by praising his works and sending an advance copy of Father Grienberger's *Catalogue comparing Ancient and Recent Latitudes and Longitudes of Fixed Stars.* He would like to know Kepler's mind on the motion of sunspots; he himself was perplexed by the fact that they moved as though on the surface of a rotating sun, and yet did not reappear "in the same place and order." He had to wait long for a reply; when it came, it came written in Kepler's own hand. Kepler's letter to Father Maelcote was written from Linz, July 18, 1613. The whole letter is of interest, for it gives us Kepler's story of the discovery of sunspots;

relates what Kepler knew of sunspots (and shows what he did not know); and furnishes a list, in his own words, of the chief books Kepler had published to date. It is worth giving in full.

> Your letter, Most Illustrious Maelcote, dated December 11 of the year '12, reached me in the month of July in the following year. The bearer was the same as its advocate, Herr Schiller. I am delighted by your Lordship's zeal for contemplative philosophy, which bares to us the wisdom of God in His works. Nor can I refrain from manifesting pleasure at your high opinion of my books. May the fruit of reading more be up to your expectations! You have rewarded me with most pleasing gifts, which are tokens of your own studiousness. Finally, you add a philosophical question, as you are indeed welcome to do. To that question I shall reply briefly.
>
> As soon as Galileo, having discovered the new stars, boasted that there were many hidden phenomena, I began to think of spots on the sun; whether by a discovery of them, we might not, perhaps, be able to prove some motion of the earth about the sun, and without doubt that the sun itself rotated. Therefore, with the convex lens of a first-rate telescope, which I had through the kindness of the Elector of Cologne (since piously deceased), I brought the rays of the sun to a focus at the focus of the telescope, with the concave lens removed. But the immense brightness of the sun, and the faintness of the image, made it impossible to see any spots. For this reason I gave up searching for spots. But some Fabricius, of Wittenberg, took them up, and published a little book on this matter in the month of June, 1611; and there followed him an anonymous Augsburgian, with the pseudonym Apelles. Having heard something of this, I returned to the telescope, and using both lenses finally saw the spots myself. For some time I failed, for the eye-piece had to be drawn out further. From that time on, various opinions were published about these spots; amongst others, the very accurate discussion of Galileo, which has been made accessible to me just today – and so I have not yet read it.
>
> On the whole, the motion or whirling of the sun, remaining in its place, is made sufficiently evident; a motion of the same kind as I, a short time before, suggested in my commentary on Mars, but of a quantity different from what I conjectured. My picture required that the sun rotate faster than Mercury revolved, quicker therefore than eighty-eight days. And that that is so, the spots testify; for they remain visible on the face

of the sun for fourteen days at most; therefore, for the same period they are hidden. Therefore a complete period is from twenty-five to twenty-eight days. Therefore, my remaining conjectures, about one or three days, for the rotation are untenable.

About the end of the year 1611, I wrote down what I thought about the substance of these spots, and I find little to change as the result of later observations. Certainly they are not all of the same speed, nor do they follow a course parallel to the ecliptic. Therefore, they are not adhering to the surface of the solar body, nor are they, nevertheless, at a perceptible distance from it. From these arguments, and because on the very face of the sun some appear, others disappear, and because they grow thicker and thinner without any order, and noticeably change their shapes, and have different speeds, it is easy to infer that the material of these spots is such as are, on the surface of this terrestrial globe, fogs and clouds, which have a motion in the air, which in some places is exceeded by the rotation of the earth. But whether they are black soot rushing forth from the most fiery firebrand of the solar body, God knows; for the analogy cannot safely be pushed further. Mästlin, indeed, thinks that he can affirm, on the authority of his sight, that the sun is not exactly round, but I am of opinion that he is deceived by optical illusions, of which the cause is to be found either in his instrument, or in the unequal clearness of parts of the sun, about which Galileo also warns.

I have compared Piffaro's fixed stars with one or two constellations from Brahe's catalogue of one thousand stars, and find them described there, although, here and there, there are emendations and changes in the numeration, or omissions. In the configurations he differs from me, for in my book about the New Star in the Serpent-Holder I emended the shape of the Serpent-Holder in accordance with the mind of Aratus and Ptolemy; also, I used the same projection from the center of the world, but according to degrees of latitude and longitude, as I explained. In the more ancient tables, he overlooks the faults in defective pictures and in the positions of the stars, as is immediately evident from the foot of the Serpent-Holder.

You write that you have four books or booklets which I have written. I produced also (5) *The Cosmographic Mystery,* (6) *On the New Star of the Serpent-Holder,* (7) *On the Birthday of Christ,* (8) *The Short Narration.* Copies of the rest are not now to be had, namely: (9) *Optics,* (10) *Letter on the Eclipse of the Year 1605,* (11) *Mercury in the Sun,* (12) *More Certain Foundations of Astrology.* And there are three German ones: (13) *On the Comet of the year 1607,* (14) *Defence of the Booklet on the Star, Against Röslin,* (15) *The Third Coming or On the Philosophical Gems of the Sounder Astrology, Against Fesel.* There is now coming: (16) *Defence of the Booklet About the Birthday, Against Röslin.* This may be had from Frankfurt.*

If you can obtain for me for a reasonable price in Belgium a Greek-Latin Ptolemy with firm type and notes of Montanus, explained by Mercator, would you send a copy to Herr Schiller to Ratisbon and I shall give him the price. It is rarely for sale here, and for not less than seven florins; at present no copy is to be had.

This I ask your Excellent Lordship to take in good part. Adieu. Linz, July 18, 1613.

This letter lacks the usual frankness of Kepler. Too well did Kepler know that the "Fabricius of Wittenberg" was David Fabricius' son Johann, who had written to him in March,

* The four works of Kepler which Maelcote had were:
1. *Dioptrice* (Augsburg, 1611).
2. *De Nive Sexangula* (Frankfurt, 1611).
3. *Dissertatio cum Nuncio Sidereo* (Prague, 1610).
4. *Astronomia Nova* (Prague, 1609).

Kepler added to this list:
5. *Mysterium Cosmographicum* (Tübingen, 1596).
6. *De Stella nova Serpentarii* (Prague, 1606).
7. *De Christi vero anno natalitio* (Frankfurt, 1606).
8. *Narratio de Jovis Satellitibus* (Frankfurt, 1611).

He reported as out of print:
9. *Astronomiae Pars Optica* (Frankfurt, 1604).
10. *Epistola de solis deliquio* (Prague, 1605).
11. *Mercuris in Sole* (Leipzig, 1609).
12. *De Fundamentis Astrologiae Certioribus* (Prague, 1602).

And three German books:
13. *Bericht vom Cometen des Jahres 1607* (Halle, 1608).
14. *Antwort auff Röslin* (Prague, 1609).
15. *Tertius Interveniens* (Frankfurt, 1610).

As forthcoming, he announced:
16. *Bericht vom Geburtsjahr Christi* (Strassburg, 1613).

He omitted:
17. *Bericht von einem neuen Stern* (Prague, 1604), which was superseded by No. 6.
18. *De Stella in Cygno* (Prague, 1606), which appeared separately as well as an appendix to No. 6.

He did not mention his ephemeral works:
19. *Kalendar* (Graz, 1595).
20. *Prognosticum auff das Jahr 1605* (Prague, 1605).

Kepler spelled *auff* with two f's.

1608, from Wittenberg. It is hardly credible that Kepler did not know, in July, 1613, who Apelles, the "anonymous Augsburgian," was. It would have been more honest to have said: "having devoured Apelles, I rushed to the telescope" than "having heard something of this I returned to the telescope." He makes no mention of Apelles' *More Accurate Disquisition,* which he had read with profit, even though he did not agree with its conclusion that the spots were on the surface of the sun. To say that Galileo's *Story,* which he calls a very accurate discussion, although he had not read it, had "been made 'accessible' to him is amphibology, as is, his statement that "about the end of the year 1611," he wrote down what he thought of the nature of sunspots. He certainly wrote nothing of the sort before he received Apelles' *Three Letters,* not earlier than January, 1612. Most noticeable in his letter is the complete absence of any mention of Father Grienberger, whose book Father Maelcote sent him, and to whom Father Maelcote referred as "my colleague." Maelcote and Grienberger were definitely colleagues; they were joint signatories of the letter to Cardinal Bellarmine, cited in the previous chapter, and together they announced to Galileo the publication of Apelles' *Three Letters.* Father Grienberger published at Rome, in 1612, his catalogue, comparing the old longitudes and latitudes of fixed stars with recent. He illustrated it with two sets of projections, one showing the two celestial hemispheres as seen from the celestial poles, the other as seen from the center of the celestial sphere, both "agreeing as much as possible with Tycho's sky and more accurate observations." His picture was not in entire agreement with Piffaro's. Kepler gave his opinion of Piffaro's; he elected to say nothing of Grienberger. Fourteen years later, however, he was to write:

> Tycho Brahe completed a catalogue of fully a thousand fixed stars before he came to Bohemia, and distributed manuscripts to the libraries of Kings and Princes. . . . It was from one of these, I would think that John (*sic*) Gruenperger (*sic*) of the Society of Jesus, drew those thousand stars in his catalogue published at Rome, for the numeration agrees.

With all evidence considered, Kepler cannot be said to have been a friend of Father Christopher Grienberger, whose name he either did not remember or deliberately garbled. Was he decidedly unfriendly? When he met Grienberger in 1597, Kepler was fresh from Tübingen. At Tübingen, Clavius was the archenemy; Grienberger was a pupil of Clavius, later his assistant, and finally, on Clavius' death in 1612, his successor. To Kepler he may have been just another Clavius; or, possibly, they crossed swords at Graz. Whatever the cause, the fact remains, they lived on this planet together for thirty-two years after they first met, and had similar tastes, but never corresponded. Throughout the last eighteen years of Kepler's life, the Jesuits ranked Father Grienberger as their leading mathematician — Kepler's single mention of him is with a garbled version of his name.

Kepler's correspondence with Father Maelcote was limited to the letter of July, 1613. When it reached Brussels, Father Maelcote was back in Rome; there, he received it in due course, and replied to Kepler. If he had only received the letter in Belgium, he said, he could have obtained a Ptolemy for Kepler from Octavio Pisani, an Italian friend, who was pursuing his studies at Antwerp. He would write to him, and see what could be done. Before anything was done, Father Maelcote died, in Rome, May 15, 1618.

CHAPTER VII

MERCURY IN THE SUN

In the fifth part of chapter eight of his *Optics,* published in 1604, Kepler considered the visibility of occulations and transits. Mercury passes between us and the sun about twelve times in a century. Kepler raised the question: Is it possible to see Mercury (with the naked eye) when it has the sun as background? His answer was "yes." And he quoted from the *Life of Charlemagne:* "On March 17, 807, Mercury was seen in the sun, like a small black spot." The life of Charlemagne from which he quoted was that included in the *Annals of the Franks,* published in 1588. The anonymous author of the life was believed to be a Benedictine monk named Adelmar, possibly the second Abbot of Wessobrun (799–831). Kepler calculated that Mercury should have transitted the sun about March 17, 808, a year later than the date given by Adelmar. The discrepancy in years, Kepler suggested, was due to the monk counting his New Year from March 25, according to ancient custom.

Mästlin, at Tübingen, did not believe that one could see Mercury while it was transiting the sun, nor that anyone had ever seen it transit the sun. He set Samuel Hafenreffer, a son of Professor Matthias Hafenreffer, the task of refuting Kepler. That the black spot seen in the sun at the time of Charlemagne was not Mercury was but one of many theses which the young Hafenreffer had to defend. The theses were all printed, and young Hafenreffer sent them to Kepler in October, 1606, asking him for his opinion on them. Samuel Hafenreffer, with Mästlin as mentor, had marshaled good arguments against Adelmar's testimony; Kepler brushed each aside. There were other histories, said Hafenreffer, including even the *Magdeburg Centuries,* which reported this black spot and said nothing about

its being Mercury in the sun. These historians, replied Kepler, were not astronomers, and they could not understand Mercury being seen in the sun. Hafenreffer cited Einhard, Charlemagne's premier, to the effect that, in Charlemagne's time, the spot was considered to have no natural explanation. Einhard, taking it as a message from heaven, wrote: "Toward the end of his (Charlemagne's) life there were many presages . . . for a period of seven days there was seen in the sun some sort of a spot of black color." Einhard, said Kepler, did not write as a witness, and he made a good story out of what he had heard, and did not understand. To the very strong argument that all the historians said the spot was seen for seven or eight days, Kepler replied that "days" was probably a slip for "times," made by one, and copied by all others. That errors could be copied, he had firsthand and immediate evidence. He himself had put forward Adelmar as a Christian confirmer of Averroes, for Averroes, a twelfth-century Arab, had, according to Copernicus, reported this ninth-century observation of Mercury in the sun. Poor Mästlin spent much time thumbing the commentaries of Averroes, before he learned that Copernicus had misquoted Pico della Mirandola saying that one Avenrodan had observed the black spot and believed it to be "Mercury in the sun."

The possibility of seeing Mercury transit the sun became so fixed in Kepler's mind that he thought he saw it transit the sun on May 28, 1607. The ephemeris for the year did not predict a transit; but Mercury came so close to the sun between May 27 and May 29, and predictions were so uncertain, Kepler thought there might be a transit. It rained all day at Prague on May 27, 1607, and was cloudy until about 4 p.m. on the twenty-eighth. Kepler was then talking to a Jesuit, whose name he does not give, about the observations which he proposed to make. As the clouds cleared, he excused himself and went home, that is to the house of the Rector of the Academy of Prague, Martin Bachazek, with whom he was then living. He betook himself to a dark shed, a *camera obscura;* the sun's rays were admitted through a small aperture, and on a piece of white paper he obtained an image of the sun – with a black spot in the left-

hand bottom corner! Bachazek was there; they moved the paper and took all precautions to preclude the possibility of the spot not being part of the image. Kepler hurried off to get witnesses; Bachazek, impatient for his return, headed for the castle, and on the way met a Jesuit, unnamed, and told him of the discovery. The good Father was on his way to prayer, and said that the sun would have to wait. Reaching the castle, Bachazek told the Emperor's valet to tell his master, and sought out Jost Bürgi, who was not at home. He commandeered two of his servants, and rigging up a dark room under the steps which led from the deambulatory between the armory and the Canon's Church, again saw the spot. Bachazek wrote a statement which one of the servants, Henry Stolle, signed. Kepler was triumphant.

To David Fabricius, his faithful correspondent since 1601, Kepler wrote and told him of his seeing Mercury in the sun. Fabricius replied: "You write that Mercury has been observed in the disc of the sun; but that this observation is impossible, I know full well." Kepler replied, in November, 1608: "About Mercury in the disc of the sun, you may burst with laughter, but by laughter you will not tear from me or my eyes the memory of what I have seen. I wrote a little book about this matter six months ago, but the printers at Leipzig do not have it ready as yet — I know not why." Very shortly after this plaint, the little book, *A Singular Phenomenon or Mercury in the Sun,* was ready. Acknowledging his copy, Fabricius wrote:

> Having carefully compared your tract with my observations, I see that a transit was possible, but I still decline to concede the observation of 808, the reason being that in that early century your method and exactness of observation were unknown.

This last was a good point; Kepler's method was unknown in the ninth century. Kepler used the *camera obscura,* the invention of which he himself attributes to J. B. Porta, who devotes the greater part of his *Natural Magic* (1560) to it. But this was no time for an amateur astronomer to speak back to the Imperial Astronomer. When Fabricius' letter reached him, Kepler was writing *finis* to his *New Astronomy,* the epoch-making book

which showed him to know more about the motions of the planets than any living man. Small wonder that Kepler ignored Fabricius and did not write to him for seven years. Rash was the man who would deny that the Imperial Astronomer had seen Mercury in the sun; rash, he was, but right. Two years later, Fabricius' son discovered sunspots; seven years later, Kepler admitted he had not seen Mercury, but a spot, in the sun.

It was on July 18, 1613, that Galileo's *Story and Proof of Sunspots* "became accessible to Kepler." When he got round to reading it, he found himself taken to task. Once upon a time, related Galileo, a spot upon the sun broke forth so large and black that men could see it with the naked eye. So deep rooted, however, was the false opinion that the heavenly bodies were immune from all change or alteration, that men believed this spot to be Mercury come between us and the sun; this was in the ninth century. "And in these our days," wrote Galileo, "not the least of Astronomers has made himself a laughing stock by believing this." Then, having recited from the *Life of Charlemagne* the story of the sunspot of 807, he concludes: "Therefore, it is certain that this phenomenon was a sunspot of extraordinary magnitude and darkness; and of such kind as could exist in these times, and which, perhaps, if we are diligent in observing, we may soon notice. So that if the discovery of these spots had come a few years earlier, Kepler would have saved himself the trouble of interpreting and explaining the passage from the *Life of Charlemagne* by changing the text and altering the date." Galileo was not the first to suggest that sunspots had been seen in the ninth century. In May, 1613, Mästlin had written to Kepler his opinion that sunspots were the phenomenon seen in 807. Kepler, of course, was neither surprised, nor impressed by Mästlin's theory. Mästlin had an ax to grind; he had already, in 1606, endeavored to refute the legend that Mercury had been seen in the sun in 807; but he had then no natural explanation to offer.

The Emperor Matthias met his first Diet at Ratisbon on August 13, 1613. He had brought Kepler along with him. He thought of suggesting to the Diet the adoption of the Gregorian

Calendar; Kepler would be his counsel. The Diet had much more serious business to discuss; Matthias found the meeting far from pleasant; indeed, it was fiery. Mention of the Gregorian Calendar would have added fuel to the flames; there was no mention of it. So Kepler had a glorious summer holiday, topped off by marriage to a twenty-four-year-old girl, "a native of his own country." Before leaving for Ratisbon, he had received food for thought from Mästlin and Galileo. At Ratisbon he had time for thought, and was thinking much about sunspots. In the cathedral at Ratisbon, when he was meant to be admiring the stained glass windows, he was looking through them. Looking through them he saw the sun; and on it he saw "traces of spots," which he pointed out to others. He had now seen sunspots with the naked eye himself, and had ample reason to suspect his famous observation of "Mercury in the Sun." But it was not until 1616 that he wrote a retraction and confessed that those astronomers who held that there was no transit of Mercury across the sun in 1607 were right; and that what he saw must have been sunspots. This public confession was wrung from him. David Fabricius, in his *Ephemeris* for the year 1615, hauled Kepler over the coals, and said it was about time he confessed. Kepler's *Ephemeris* for the year 1617 came out with a long preface, which was an open letter to Fabricius. Time had paved the way for Kepler; both Welser and Johann Fabricius were dead. Kepler condoled with Fabricius on the death of his son; better than any apothegm or epitaph, he said, was Johann's little book on sunspots "published in 1611." Coming to his own profession of beliefs, he continued:

> If this will satisfy your claims, let me say, that sunspots were seen by your son long before they were by Apelles, as I have testified at Prague, and testify again now. . . . The most accurate diligence of Galileo has left nothing to you or to me to discover about these sunspots; his letters to Marc Welser (now piously deceased), written in Italian, I recommend you to read; they are good enough to be translated into Latin.
>
> Did I pass off Mercury as a spot I saw? Then I am the lucky one who was the first, in this century, to observe sunspots; I steal the palm from your son; I take it by the same right by which Marius takes from Galileo the honour of having been the first to observe the satellites of Jupiter; for if I did not know I saw sunspots, neither did he, in the beginning, know he was seeing satellites of Jupiter when he was looking at them. However, neither to me nor to your son should go the glory of this discovery. Eight hundred years ago another astronomer saw them thinking he saw Mercury in the sun. And in these our days, when we had clearer evidence of spots, it was Mästlin who conquered . . . it was he who first suggested that I had seen a spot in 1607 and professed, like the astronomer of old, that it was Mercury. . . .
>
> Since I have said much in the preceding paragraphs of sunspots and of my *Singular Phenomenon* (which was certainly incorrectly called *Mercury in the Sun*), evident injury would be done to the eminent (and, indeed, profound) Florentine Philosopher, Galileo, if in this place I did not quote two passages from his book published at Rome long before the Fabrician protests. . . .

The two passages quoted from Galileo are from his *Story*, which Kepler got in 1613. In the first passage he takes Kepler to task for not believing that a spot was seen in the sun in 807: that was bad, Galileo said, since the scribe tells us that the spot was visible for eight days, which a spot could not be; and Kepler was not justified in thereupon taking the "eight days" to be an error for "eight times." The second passage quoted was that in which Galileo mitigated his harsh words about Kepler. Kepler, he admitted, was a very keen observer to have seen the spot in 1607; and he did not doubt but that Kepler already had changed his mind, and admitted that it was a spot he saw, and that the transit (if there was a transit) was merely the occasion — the occasion which moved him to watch so diligently. Kepler, having quoted these two passages, dismissed them briefly.

> These he wrote in 1612. What I should reply to them, and what I wrote to him in letters about this matter, the reader may gather from my previous paragraphs.

This was a very convenient way of dealing with these passages. There is neither confirmation nor denial of Galileo's charitable belief that Kepler had already in 1612 given up the idea that he had seen Mercury in the sun. And while Kepler

gives his readers to understand that he had written to Galileo on the subject, not only have the letters not come down to us, but Galileo, writing to Julian de Medici in 1615, complains that he has not heard from Kepler.

Kepler was suave. He kept out of the controversy on sunspots as long as possible. He steadfastly declined to write to Welser. With two of the protagonists in the grave, he faced the rest to clear himself. He handed bouquets to each one who had any claim, except Apelles. He mentioned Apelles, only to deny that he was prior to Fabricius; and at this time he knew that Father Scheiner was Apelles.

The preface to his *Ephemeris* for 1617 was the nearest thing to a disquisition on sunspots that Kepler published, and it was his first published statement about them. His references to sunspots thereafter can be counted on one's fingers. In his *Epitome of Astronomy,* both in the first part (Linz, 1620) and in the second part (Frankfurt, 1621), he cited the motion of sunspots as evidence of his theory that the sun rotated and was the cause of motion of the planets. In a published letter to Johann Bartsch, written in 1629, he recounted how at Puzbach he had obtained an excellent image of the sun with its spots, by using the Landgrave Phillip's kind of *camera obscura.* What he had seen, he said, bore testimony to the truth of his conjecture in his *Epitome* that sunspots were soot or smoke emanating from the sun. He did not live to see Father Scheiner's monumental work on sunspots, which was published the year he died. He did not recognize him as an authority on sunspots, although he did, at least when it suited him, regard him as an authority on the sun. When he read the commentary of Philip von Lansberg, he found the editor, Martin Hortentz, discrediting his value for the diameter of the sun. Hortentz maintained that the diameter of the sun ranged from 33½ minutes, when we were nearest to it, to 36 minutes, when we were furthest from it. To this Kepler replied that he had this very year measured the diameter of the sun and made out its mean value to be 30 minutes, and that he had observed also its elliptical form when setting (when its vertical diameter is less than this); in all of which, he said, he

was borne out by "Father Scheiner, Cysat, Galileo, and others." But if he liked the accuracy of Father Scheiner's observations (and, by the way, they were not so accurate – no more accurate than Kepler's – for the diameter of the sun is 32 minutes), he did not like his theory of the terracentric universe. Scheiner would not hear of a moving earth; he had already become a notorious bigot on this point before he came to Rome in 1630. He was in Rome from 1630 to 1633, three fateful years in Galileo's life. There seemed to be some ground for suspecting him of having part in the summoning of Galileo before the Inquisition – this suspicion was scarcely rash, though in reality it was false. After Kepler's death he endeavored, according to Kepler's son Ludwig, to obtain from the Emperor Kepler's manuscripts; he desired, claimed Ludwig Kepler, to suppress all doctrines and hypotheses which he deemed to be displeasing to the Church. He was, according to Kepler's son, no friend of Kepler.

There exists only one letter from Father Scheiner to Kepler, written from Ingolstadt, April 10, 1615. It runs as follows:

> I sent recently, Illustrious Sir, the *Mathematical Disquisitions* of my pupil; now I gladly forward my own work. About a solar phenomenon, it is small in size, but entailed more labour than one might think. You see the first rough outline; embellishments, I hope, will come later. If you write me your opinion of it, I shall be indebted. Your *Paralipomena,* for which I had the booksellers looking for a long time, I obtained after I had completed my work. I read it eagerly, and appreciated all the more the line of reasoning by which you argue to a contraction of the sun.
>
> Meanwhile I ask you, what do the *kaumata* and *chasmata* seem to you to be? That they are fire has always seemed to me to be far from the truth. Also, have you seen the five haloes round the sun this month, and what do you think of them, or how do you explain them? Farewell, Illustrious Sir, and take in good part my little gift. Your, Chr. Scheiner, Soc. Jesu.

Compared with contemporaneous letters, this stilted and staccato note must be classified as stiff – it is not the letter of a friend to a friend. Father Scheiner's *Elliptical Sun,* which he

sent to Kepler, might have served to draw Kepler toward him. Kepler, in his pretelescopic *Optics* or *Paralipomena,* as Scheiner calls it, had shown from the laws of refraction that the sun ought to look flattened when near the horizon. In his *Elliptical Sun,* Scheiner, by many accurate measurements, shows that it does appear elliptical in shape when near the horizon, and explains the phenomenon by refraction. Here there may be noted a consistent difference between Father Scheiner and Kepler: Kepler was a theorist, his theories were *a priori;* Father Scheiner was Galilean, if we consider Galileo the early seventeenth-century exemplar of the experimental method. Father Scheiner reduced Kepler's theory of the telescope to practice; by experimental means he arrived at the same conclusions about the effects of refraction on the shape of the sun, as did Kepler by deduction; and he verified experimentally (as explained in *The Eye,* Innsbruck, 1619) Kepler's theory of ocular optics.

But if Father Scheiner was Galilean in his methods, he was not in his conclusions – his judgment on the heliocentric theory was: "it is not proved." His *Mathematical Disquisitions* showed that that theory, already open to many objections, had in no way gained by Galileo's discoveries. Now, the heliocentric theory was essential to Kepler's "New Astronomy"; if the *Elliptical Sun* was pleasing to him, the *Disquisitions* must have been positively offensive. He compromised by ignoring Scheiner. It must be remembered that at the time when Father Scheiner aired his anti-Copernican ideas, the question was moot in Catholic schools. It was not until two years later that the Congregation of the Holy Office stigmatized as "altogether contrary to Holy Scripture the false doctrine of Pythagoras on the movement of the earth and the immovability of the sun, taught by Copernicus in his work *On the Revolutions of the Celestial Spheres.*" Not all of Father Scheiner's brethren were in agreement with him, and with great glee did Kepler, in the very beginning of his *Epitome of Copernican Astronomy,* quote Father Clavius as saying that the death knell of the old hypotheses was sounded by the discovery of the phases of Venus.

CHAPTER VIII

HELIOCENTRIC HYPOTHESIS

On December 14, 1613, the Benedictine Father Benedetto Castelli, professor of mathematics in the University of Pisa, wrote the following interesting details to Galileo:

> On Thursday I dined at their Highnesses' table. The Grand Duke inquired how my lectures were attended. Finding him interested, I ventured to give some minute particulars. He asked if I had a telescope. I answered that I had, and gave an account of my observation of the Medicean planets of the preceding night; and Her Serene Highness interrogated me as to their positions. At this point some began to say that surely these must be realities, and not deceptions of the instrument; and their Highnesses turned to Doctor Boscaglia, who gave as his opinion that the existence of these planets could not be denied. I then took occasion to tell what I knew of your wonderful invention, and of your having determined the periods of revolution of the planets in question. Don Antonio was at table, and manifested himself pleased at all I said. At length, after many solemn ceremonies, dinner came to an end, and I took leave. But scarcely had I left the Palace when Her Serenity's lackey came after me, and called me back. But before I tell you what followed, I should mention that during dinner Boscaglia was talking privately to Her Highness for a while, and he said that though the celestial novelties discovered by you were conceded, yet the motion of the earth was incredible, and could not be, for it was evidently contrary to Holy Scripture.
>
> To return: I entered Her Serenity's sitting room, where there were the Grand Duke and Her Grace the Duchess too, and Don Antonio, Don Paolo Giordano, and Dr. Boscaglia. Here Her Serenity, after a few inquiries as to my condition in life, began to argue against me, quoting Holy Scripture; and I, with all due deference, replied with a theological exposition, such as you would have been delighted to hear. Don Antonio

> backed me up, and so encouraged me, that despite the majesty of their Highnesses, I bore myself like a palatin. The Grand Duke and Duchess were on my side, and Don Paolo Giordano very opportunely cited a piece of Scripture in my defence. So that at the end Her Serenity was the only one who contradicted me; and I judged that she did it only to draw me out. Signor Boscaglia did not say a word one way or the other.

Galileo's reaction to this letter was: "Would that I had been there!" He would have quoted Scripture to Her Serenity, the dowager Grand Duchess Christina of Tuscany; and he would not have needed Don Paolo to help him. He sat down and wrote to Father Castelli what he would have said, and what he hoped Father Castelli would say, if he got another such occasion. He endeavored to prove that the earth moved, and that its motion was in no way denied by Scripture; he, Galileo, was right, and Scripture did not err. "Though Scripture cannot err," he wrote, "its exponents and interpreters are liable to err in many ways; in particular, there would be serious and frequent error if one were to stop short at the literal signification of words." And he continued on until he had penned what was virtually a short dissertation, though a long letter, on exegesis. Father Castelli thought the letter wonderful and would have others share his admiration. It was copied, and spoken of, far and wide. It became known to the Dominicans at Florence, who were all stout Aristotelians, and had already fallen foul of Galileo, who had blasted sky-high *Aristotle's Mechanics* (which, it is now admitted, was not written by Aristotle at all). Now here was this layman teaching them how to interpret Holy Scripture!

On the fourth Sunday of Advent, December 21, 1614, one of the Dominican Fathers of Florence, Father Caccini, was preaching in the church of Santa Maria Novella. Considering the day, one might have expected a sermon on the third chapter of St. Luke, or on the beginning of the fourth chapter of St. Paul's first Epistle to the Corinthians. Father Caccini went to the tenth chapter of Josue; the thirteenth verse said: "And the sun and the moon stood still" – that was the beginning. The body of the sermon was a tirade against Galileo; and the conclusion was that if we were to believe the word of Holy Writ and the

teaching of the Fathers, then the teaching of Galileo was false and quasi heresy. This was from the pulpit a public attack and a serious charge. Galileo wrote a polite note of protest to Father Luigi Maraffi, Master General of the Dominicans, resident in Rome. Father Maraffi replied that he was deeply mortified by the scandal that had been caused by Father Caccini; the sermon, of course, had been preached without his knowledge or consent, but, as it was his misfortune to be answerable for all the *faux pas* which thirty or forty thousand of his brothers in religion might make, he would write to Father Caccini and, if possible, get him to retract. He did write. Father Caccini and his brethren shrugged their shoulders; Father Maraffi was not conversant with the facts. Together they considered what should be done and decided to denounce Galileo's letter to the Inquisition. Father Lorini was deputed to do the denouncing. He sent a copy of the letter to Cardinal Paolo Sfondrato, one of the Inquisitors-General, with the following explanation:

> All our Fathers of this devout convent of St. Mark are of opinion that the letter contains many propositions which appear presumptuous or suspect, as when it asserts that the words of Holy Scripture do not mean what they seem to mean; that in discussions about natural phenomena the authority of Scripture should rank last; that its exponents have very often erred in their interpretation. . . .
>
> When I saw that . . . the followers of Galileo . . . were taking upon themselves to expound the Holy Scripture according to their private lights and in a manner different from the common interpretation of the Fathers of the Church; that they strove to defend an opinion which seemed quite contrary to the sacred text; that they spoke slightingly of the ancient Fathers and of St. Thomas Aquinas; that they were trampling down all Aristotle's philosophy, which has been of such service to scholastic theology; and, finally, that, to show their cleverness, they were airing and disseminating in our constantly Catholic city a thousand impudent and irreverent surmises; when, I say, I observed all this, I determined to acquaint your Lordship with the state of affairs, that you, in your pious zeal for the faith, may, together with your illustrious colleagues provide such remedies as may appear advisable. . . .

When Galileo heard that his letter to Father Castelli had been sent to Rome, he was not downcast. Quite the contrary, he rejoiced for he was confident of a complete vindication, and the confusion of his opponents. Nothing, he reckoned, but misrepresentation could condemn him. To forestall this possibility, he made sure that Rome had an accurate copy of his letter; he wrote to Monsignor Dini at Rome:

> I thought it would be well to send your Reverence an accurate copy of the letter. You would oblige me very much by reading it to Father Grienberger, that excellent mathematician and very dear friend and patron. If you consider it advisable, you might also find some opportunity of bringing it to the attention of Cardinal Bellarmine, as I am given to understand that the Dominican Fathers are proposing to apply to his Lordship. . . .

One of Father Grienberger's claims to be an "excellent mathematician" in Galileo's eyes was that he had written, the previous year, to a friend of Galileo's, that he agreed with Galileo on the question of flotation, and disagreed with Aristotle; and that it was nothing wonderful to find Aristotle wrong, as he was wrong on many questions. He was Galileo's "patron" only by adoption; Galileo adopted him as successor to Father Clavius. Clavius was so favorably disposed toward Galileo and so highly thought of by succeeding Popes, that it would have been rash for anyone to denounce Galileo while Clavius lived.

A few weeks passed before Monsignor Dini replied to Galileo; but he was working for him, and did not spare himself. On March 7, 1615, he wrote to Galileo:

> The thousand shows and celebrations during these days of carnival have deterred me from seeking the persons with whom I desired to have audience. However, I have compensated for the deferment by having several copies of your letter to Father Castelli transcribed. One of these I presented to Father Grienberger, and, at the same time, I read to him your letter to me. Several other people also have had copies given to them, and I had a long conversation with Cardinal Bellarmine about the points you mentioned.

> He assured me that since you and he had discussed the astronomical question together, he had never once heard it aired in any way. As to Copernicus, his Lordship said that he could not believe that his work would be forbidden, and that, in his opinion, the worst that could happen to it would be the insertion of a note stating that the theory was introduced to save the appearances, just as epicycles had been introduced, or some similar expression. With this reservation, he continued, you would be at liberty to speak on these matters whenever you had occasion to do so. Concerning the points at issue, it seemed to him that the passage of Holy Scripture most opposed to the new interpretation of the celestial phenomena was the Psalmist's text, "Hath rejoiced as a giant to run the way," together with the words that follow, as all commentators up to the present time have understood it to imply that the sun is in motion. I answered that the Holy Scripture, in this place, might be considered as simply employing our usual form of speech, but the Cardinal said that in dealing with such a question we must not be too hasty, just as it would not be right to rush into condemning anyone holding the views which I had put before him. He added that if you had any cogent reasons for the views given in your letter, he would be very pleased to study them. . . . Then he told me that he intended to invite Father Grienberger to his house to discuss the question with him, and this morning I have been to visit the Father, to see if there was any further news. I found there was nothing new, except that Father Grienberger would have preferred you to have given your proofs before beginning to speak about the Holy Scripture. I replied that if you had done this, you would have been accused of giving your own facts preference to the word of God. As for the arguments which I put forward on behalf of your views, the Father said that he doubted whether they were not more plausible than sound. . . .

Galileo was lobbying by letter. He had not only written to Monsignor Dini, but also to Monsignor Ciampoli, who reported to him on March 19, 1615:

> The great rumours which were supposed to be in circulation here have, to the best of my belief, not gone further than to the ears of four or five people at the most. Monsignor Dini and I have both been trying to find out whether there was much stir, but it appears that the matter is not being talked of at all; therefore the report that all Rome was talking

about it, must have been invented by the prime movers of all this fuss.

This morning Monsignor and I were with Cardinal del Monte, who holds you in great esteem. His Eminence told us that he had had a long talk with Cardinal Bellarmine about your case. They had come to the conclusion that no objection could be raised to your treating of the Copernican system, or of your offering demonstrations of its truth, as long as you avoid introducing Holy Scripture, the interpretation of which must be reserved to approved theologians. . . .

A book has recently been published at Naples which attempts to show that the doctrine of the motion of the earth and the immobility of the sun is not opposed to the Sacred Scripture, or to the Catholic faith. This book is in great danger of being suspected by the Congregation of the Holy Office, for the reason I mentioned above, namely that it drags the Scriptures into the discussion. . . .

Galileo had not printed or published anything like he wrote to Father Castelli; Monsignor Ciampoli's letter was a delicate warning not to do so. Galileo resented being restrained from quoting Scripture to prove the truth of what his opponents endeavored to prove false from Scripture. He had already written many pages of an apology, addressed to the Dowager Grand Duchess, and cited Scripture and the Fathers of the Church liberally to vindicate his stand. Now he added:

> Would that they [the Dominicans of Florence] would try to refute the arguments of Copernicus and his followers, and leave the task of condemning erroneous doctrines to those to whom it belongs, and not expect to find in the discreet and prudent writings of the Fathers, or in the wisdom of Him who cannot err, those rash conclusions to which they are led by personal interest and passion!
>
> Of course, no one doubts that the Sovereign Pontiff has the power to condemn or approve propositions which are not strictly of faith; but it is not in the power of any man to make them true or false other than they are in fact.

Galileo had rejoiced when his case went to Rome; now he chafed; he had not yet obtained the swift judgment he expected. He became definitely restless when he heard that Father Caccini was in Rome, and had given evidence to members of the Con-

gregation of the Holy Office, and that a request had been sent to Florence for more witnesses. He decided that he would go to Rome himself. His friends tried to dissuade him; their words were of no avail. He set out armed with a written permission from the Grand Duke, addressed to Cardinal del Monte.

> Galileo, a mathematician well known to your widely renowned Eminence, informs me that, having felt himself deeply aggrieved by the calumnies which have been spread by certain envious persons, namely, that his writings contain erroneous opinions, he has, of his own accord, resolved to go to Rome, and has, for this purpose, asked my permission, having a mind to clear himself from such imputations.

Those who knew Galileo knew that he enjoyed a better reputation with those who did not know him. In person, he was provocative and headstrong; he was neither modest nor persuasive. Pietro Guicciardini, the Tuscan ambassador at Rome, knew him, and on December 5, 1615, he wrote to the Grand Duke's secretary, Picchena:

> I hear that Galileo is coming to Rome. . . . His views on science and some other matters are not to the liking of the Consultors and Cardinals of the Holy Office. . . . I do not know if he has changed those opinions, or whether his temper is any better, but I do know that some of the brothers of Saint Dominic, and others, who are very influential in the Holy Office, bear him no good will. And this is no place to come to dispute about the moon, nor is this the age in which to propound and defend novelties.

The writer of this letter became Galileo's host in Rome. Galileo was delighted with his reception. He wrote to Picchena that he was glad he came; he had the opportunity of demonstrating his theories to distinguished gatherings, and of dissipating calumnies. Guicciardini was not so pleased with Galileo's coming, nor with his activities, nor with his prospects. From him, Picchena heard a different story.

> Galileo prefers his own opinions to those of his friends. Cardinal del Monte and other Cardinals of the Holy Office, and I myself (though I have not much influence with him)

have endeavoured to persuade him to keep quiet, and not to cause commotion, or, if he would hold his own opinions, not to try to shove them down other people's throats. . . . On Wednesday last, Cardinal Orsini, in Consistory, spoke to the Pope on his behalf. The Pope said that his Eminence would do well to persuade Galileo to abandon his opinion . . . that the question was being considered by the Congregation of the Holy Office.

It was Consultors of the Holy Office who were considering the question. On February 19, 1616, a committee of eleven theologians was asked to give its opinion on two propositions concerning the position and motion of the sun and the earth. Five days later they reported to the Congregation of the Holy Office as follows:

First Proposition: The sun is the center of the universe and altogether devoid of local motion.

Decision: All were agreed that this proposition is philosophically foolish and absurd, and is formally heretical inasmuch as it expressly contradicts the teaching of many texts of Holy Scripture, both according to their literal meaning and according to the common explanation and interpretation of the Holy Fathers and learned theologians.

Second Proposition: The earth is not the center of the universe nor immovable, but moves both as a whole and with a diurnal motion.

Decision: All were agreed that this proposition merits the same censure in philosophy, and that, theologically considered, it is at least erroneous in faith.

A modern might say that the cause of these erroneous decisions was twofold, namely, (1) the theologians did not know their exegesis as well as Galileo did; (2) they knew their astronomy better than he did. Galileo was a poor exponent of the heliocentric doctrine. He had three "proofs" of its truth, drawn, respectively, from his observations of the tides, sunspots, and the phases of Venus. His argument from the tides was false; his argument from sunspots proved nothing; and his argument from the phases of Venus was plausible, but inconclusive. As regards the tides, he said that their ebb and flow were due to

the unequal velocities, through space, of the various parts of the earth's surface, and that these inequalities could not exist if the earth did not both rotate and revolve. If that was not the cause of the tides, what was, he asked. Well, said some, Kepler suggests the attraction of the moon; rubbish!, said Galileo. His argument from sunspots was ingenious. He had observed that twice a year sunspots travel across the solar disc in a straight line, and that other times their paths were curved; he explained that the sun rotated about an axis which is inclined to the plane of the earth's orbit, and that twice a year the earth would be in the plane of the sun's equator, and that at those times the motion of a point on the sun's equator would appear to us as a straight line. As, however, a similar explanation would hold if the sun revolved about the earth, the argument proved nothing for or against the heliocentric hypothesis; the theologians would readily admit the rotation of the sun, and, probably, would have no objection to its axis being inclined. The phases of Venus indicated that Venus was revolving about the sun; the most that could be concluded was that possibly the earth was also; in the Tychonic system, Venus revolves about the sun, and the earth does not.

It must be remembered that the judgment of the theologians, handed to the Congregation of the Holy Office, was a confidential report; it was not made public; neither were the minutes of the meetings of the Congregation public. In these, for February 25, 1612, it is recorded that the report of the theologians was received, and that, as a consequence, the Pope instructed Cardinal Bellarmine to summon Galileo and admonish him to abandon his opinion about the motion of the earth and the immobility of the sun. If, and only if, Galileo declined to abandon his opinion, he was to be ordered to abstain from teaching, defending or discussing it; if he refused to promise to do this, he was to be imprisoned. Cardinal Bellarmine's disagreeable task was simplified by Galileo's agreeing to abandon his opinion; he received no order, no threats. The work of the Congregation was also simplified; Galileo's case was

closed. In the public decree, dated March 5, 1616, his name was conspicuous by its absence; and later ages noted that the word *heretical,* used by theologians was also, noticeably, omitted. The decree forbidding Copernicus' book, "until corrected," ran as follows:

> Since it has come to the notice of the said Congregation that the false doctrine of Pythagoras, altogether contrary to Holy Scripture, on the movement of the earth and the immovability of the sun, taught by Copernicus in his work *On the Revolutions of the Celestial Spheres,* and by Diego de Zuniga in his work on Job, is already widely spread and has been adopted by many persons, as may be seen in a letter by a Carmelite Father, entitled *A Letter of the Rev. Fr. Foscarini, Carmelite, on the Opinions of the Pythagoreans and Copernicus, concerning the Movement of the Earth and the Stability of the Sun, and the New Pythagorean System of the Universe,* printed at Naples in 1615, in which the said father endeavours to show that the said doctrine is in accordance with the truth and not opposed to Scripture, the Congregation, in order that this opinion may not spread further, to the detriment of Catholic truth, has determined to suspend the two works of Copernicus and Diego de Zuniga until they be corrected, and to prohibit entirely and condemn the book of Fr. Foscarini, and to prohibit also all other books teaching the same doctrine, as by the present decree it prohibits, condemns and suspends all and each.

A few days after the publication of this decree, Galileo had "a most benign audience" with the Pope. The kindness of the Pope encouraged him to stay on in Rome, hoping yet to confound his enemies. His host, Guicciardini, pulled wires to have him move; and the secretary to the Grand Duke wrote to Galileo:

> His Highness desires you to let sleeping dogs lie, and come from Rome without further delay; for we have heard reports which are not pleasant.

His Highness was the one person whom Galileo was quick to obey; he depended on him for his living. Within a few days he was on his way to Florence; but, beforehand, he had procured a document testifying that he had not been censured in Rome.

One who was destined to be a Saint and Doctor of the Church wrote for him:

> We, Robert Cardinal Bellarmine, having heard that Signor Galileo Galilei has been calumniously reported to have abjured in our hand, and, besides, to have been punished with a salutary penance, and having been asked to make known the truth as to this, declare that the said Signor Galileo has not abjured in our hand, nor in the hand of anybody else here in Rome, nor, as far as we are aware, in any other place whatever, any opinion or doctrine held by him; neither has any penance, salutary or otherwise, been imposed upon him. All that happened was this: the declaration made by the Holy Father, and published by the Sacred Congregation of the Index, was intimated to him, wherein it is declared that the doctrine attributed to Copernicus that the earth moves round the sun, and that the sun is in the center of the universe and does not move from east to west, is contrary to Holy Scripture, and therefore cannot be defended nor held.
>
> In witness whereof we have written and subscribed these presents with our own hand this 26th day of May, 1616.

Thus ended Galileo's first clash with the Inquisition. Sixteen years later he broke into controversy again, and grievously offended. For this, in 1633, he was meted out a salutary penance.

The ban on Copernicus' book did not make the stir that one might think, or that Galileo thought. Three years later, Kepler received a letter from Doctor Remus. Writing from Vienna, he said: "Galileo would like you to send him a copy of your Copernican book, because it is forbidden in Florence (as well as Rome), and he cannot get a copy." This Remus, physician to the Archduke Leopold, came to Prague with him in the troubled year of 1611, when the Archduke seized part of the city. There Kepler met him, and talked science. Their conversations, rudely interrupted by the Archduke's ejection, were continued in succeeding years by correspondence. On August 4, 1619, Kepler wrote to Remus:

> The first I heard of my book being prohibited in Rome and at Florence, was from your letter. I do not understand what you mean by my Copernican book; all my books are Copernican

> — even the introductions to my Ephemerides. The *Harmonics* is not yet published. . . . I suspect, therefore, that you speak of my *Epitome*. I pray you to send me the formula of censure. . . . It means much to me to know whether the same censure will apply to Austria.

Remus replied nine days later:

> I shall send the *Epitome* with your letter to Galileo as soon as possible, and I do not think that that book will be prohibited, except inasmuch as it may speak contrary to a decree of the Holy Office of two years ago, or more. It was then the case of a Neapolitan religious (Foscarini) who was spreading these opinions among the people by writings in the vernacular, whence were arising dangerous consequences and opinions, whilst Galileo, at the same time, was pleading his cause at Rome with too much insistence. And, thus, Copernicus has been corrected, for some lines at least, in the beginning of his first book. But it may be read with permission, and (as I suppose) this *Epitome* also, both by the learned and those versed in science, both in Rome and throughout Italy. There is no grounds for your uneasiness, either as regards Italy or Austria; only keep yourself within bounds, and put a guard on your feelings.

Kepler had long ago been taught to guard his feelings, and to keep Scripture out of his discussions. Tübingen, in 1596, insisted that he keep Scripture out of his *Cosmographic Mystery*. He did; the opening words of Chapter I read:

> Although it be pious to begin this disputation about nature by seeing whether it contains anything contrary to Holy Writ, nevertheless, I judge it untimely to start this controversy here, and I promise, in general, not to say anything that would be damaging to Holy Writ.

In 1621 Kepler put out a revised edition of his *Cosmographic Mystery*. The revision consisted in footnotes. As a note to the opening words, quoted above, he pointed out that Copernicus had alluded to the Scripture difficulty in the dedication of his book to Pope Paul III; "and now," Kepler continued, "his words are condemned more than seventy years after their publication and his death. 'It is suspended,' says the censure, 'until

corrected'; my opinion is that 'until explained' is what is meant." Did Kepler remember that on March 28, 1605, he had written to Herwart: "Wisely, I think, has the Roman Church, while condemning future telling astrology . . . left the philosophy of Copernicus alone"?

CHAPTER IX

COMETS

When Kepler was five, and going on six, his mother brought him to a high place to see the great comet. The young Johann was filled with wonder; it was a nice thing, and it seemed very far away. But his mother, obviously, didn't like it, for the womenfolk around him were all uneasy. They spoke of signs from God, of war and pestilence, and of the new Emperor, Rudolph II, who had come to the throne the previous year; and Kepler did not understand.

At Tübingen, Kepler learned much about comets. He learned how Tycho Brahe had shown that they were out among the planets, and not so near to us as people thought. He learned that while they always seemed to cross the sky on curve paths, no one could explain why, or how, their ways were arcs of circles. In 1596, Kepler put out his *Cosmographic Mystery,* which was to explain, and confirm, Copernicus' doctrine. In it he pointed out, fallaciously, that if one would concede a moving earth, the problem of the comets would be solved — they moved in straight lines, which appeared curved because of the curvilinear motion of the earth through space.

As Imperial Mathematician, Kepler had access to Brahe's observations of the comet of 1577, and his notes on comets of previous years and ages. He examined Brahe's cold figures with the detachment of a student surgeon studying the entrails of a rabbit. Comets had no fear for him; to him they were but another astronomical phenomenon. In his thirty-fifth year, he could say that he had never seen a comet since he had come to the use of reason. In his *New Star,* in 1606, he coolly said that comets were formed from the luminiferous ether, a stuff a little more dense than the stuff of dreams. The following

year a comet appeared in the sky; Kepler saw it for the first time on September 26, 1607. He noted its position in the sign of the Lion, and in the constellation of the Big Bear, and nearly half way between two second magnitude stars, Gamma of the Big Bear and Beta of the Lion. He could not refrain from writing to Brengger: "Your letter was prophetic. You prescribe a method of observing the parallax of comets. Here is your comet, which I first saw on September 26, 18° in the sign of the Lion." Thereafter, he learned to keep silence. The people were afraid; among the learned, some were not too sure. Kepler himself had unwittingly paved the way for solid belief that it was a sign from God. Whence was it come? Formed from ether? How? Kepler said, "by special creation." God, then, created this comet, here and now. But why?

A few years before the comet appeared, Shakespeare put into the mouth of Caesar's wife a thought of the times:

> When beggars die, there are no comets seen;
> The heavens themselves blaze forth the death
> of princes.

One did not air such thoughts when a comet was in the sky; princes would not like it; one might whisper them, but not declaim them from the stage. Among the cultured, it was bad taste to discuss the comet; among the pious, it was considered a bit irreverent; comets were from God; they were a sign; a sign of what? God knows.

While the comet was in the sky, the mention of it in Kepler's correspondence is remarkable by its absence. There is a marked contrast between his letters, received and written, at the time of the appearance of the New Star of 1604, and at the time of the appearance of the comet. The New Star, in the minds of men, might bring good tidings of great joy; a comet was an evil thing. Kepler did not let it interfere with his other work; but he kept it out of the lengthy letters which he wrote, at this time, about the year of the birth of our Lord. And Herwart wrote to him almost interminably on everything scientific under

the sun; but he did not discuss the comet – neither did he ignore it, dismissing it cryptically with: "The comet will give people something to think about."

Actually the comet which Kepler saw in 1607 was that which we call Halley's comet. In 1682, Halley observed it, and computed its timetable. He made out that the comet seen in the years 1531, 1607, and 1682 was one and the same. Since then its history has been traced further back, and Halley's hypothesis verified – it travels on an elliptical track; we, on the grandstand of the earth, see it as it passes close. Until 1378, it used to show up on an average of every 77 years; now it has cut its time to 75 years per lap. In this era, it first appeared about the time St. Peter died. It appeared, as Kepler read, in time to tell that the days of Louis, le Débonnaire, were numbered. It appeared to offer a satisfactory explanation of 1066 and all that – and so worked its way on to the Bayeux tapestry. It was particularly bright when it came in 1223; and Philip II soon died, after beautifying Paris. In 1378 it appeared "with its tail turned to the west, as portending war, insurrection, and treason." The fearful did not fear the worst; it spelled schism, the Great Schism. With this memory, the people of Christian Europe were terrified when it showed up in 1456, three years after the death of Constantine, for the capture of Constantinople by the Turks and the end of the Eastern Empire; it was no sign of God, but in league with the devil. In 1531 it was terrifying in aspect; men said it meant no good; later years, looking back, agreed: there was an earthquake in Lisbon; there were inundations in Holland; Zwingli was killed in battle. In 1607 it came again, and Kepler was perplexed. After it was gone, he wrote to Herwart: "Whatever the immediate future brings will be ascribed to the comet, which, in the popular mind, is astrological; and unless you promise something from so great a sign, astrologers, with their comets, will not be kindly spoken of." What could he promise? What should he write? He, of all men, the Emperor's astrologer, what should he write?

Kepler's first move was to watch the comet, and say that

its course must be observed before any judgment could be given. After October 26, he saw the comet no more, and had to get ready something to show the Emperor. For a start he wrote, in German, a little tract on comets in general. It was a good piece of work for his time, considering the paucity of observed facts at his disposal. The first question was that of the distance of the comets from the earth. Here he was precise; he did not draw a conclusion beyond his premises. He said, that while Brahe proved that the comet of 1577 was further away than the moon, he did not prove that every comet was further away from us than the moon. Kepler searched history, and the records of astronomers, and found sufficient evidence that many comets were further away than the moon; more than that he would not say. As regards their motion, he reiterated what he had said before, and would say again, i.e., they moved in straight lines, which seemed curved because of the earth's motion. Also he repeated his theory as to their origin, but this time, he had decided, as we have already said, to say that they were created. They were created from the stuff between the stars; when they disappeared, they just evanesced. Through intuition, rather than deduction, Kepler arrived at sound conclusions about the light of comets. They were not self-luminous, but reflected the light of the sun, and were translucent, if not transparent. As for their tails, that was easy; the head of any woman flying with her hair against the wind would seem to have a tail. Writing of comets in general, was easy, but it was with a heavy heart, and a slow hand, that he wrote: "Part II. Of the Comet of 1607 in Particular."

Before he wrote the second part of his tract, he received a couple of letters that proved useful. Written after the comet had departed, they told of its first appearance and of its disappearance. Dr. Brengger wrote: "I first heard of the comet from a monk of Ursim Monastery (which is about an hour's journey from here), who told me that he had seen a comet at about 10 o'clock on the night of September 23, and on succeeding nights." Father Ziegler broke a year's silence to write to Kepler all he could collect about the comet, which

he thought might be useful to the Imperial Astronomer. He wrote:

> Before September 24, I knew nothing of a comet; on the morning of the twenty-fourth, at 4 A.M., looking from my window, through the misty air, I noted something unusual about the shapeless star which is between the Big Bear's tail and the tail of the Lion, which some make the little chain of Boötes. On the twenty-fifth I was not able to observe anything, but that day, at dinner, the Father Prior of the Dominicans of Cologne said that in his journey, the previous night, he had seen a comet. He could not indicate the place; nevertheless, his judgment was rendered more probable by my observation of the morning before. On September 26, the Carthusian brothers of Mainz, on their way to matins, noticed something similar. On September 29, with a clear sky, after it had been raining or cloudy most of the night, I observed clearly a cloudy tail, directed toward the third last star of the Big Bear's tail. From this it was distant 17¼°, from the last star of the tail 14° 50′, from which I compute its longitude as 166° 58′, and its latitude as 39° 44′, although I think in measuring the distances I may have erred a little, as the instrument which I was forced to use was a makeshift, and not level, as no other could be conveniently got at the time. On October 8, it was a little in from the star of the left hand of Ophiuchus, and to the north of it; from that time I saw it oftener until the fifteenth and twentieth of October, after which I could not see it, on account of the inconvenient view, for it was too low at the time of night at which I could observe. But I noticed that it was heading toward the seventeenth degree of the Archer, that is, toward the place of the New Star of the year 1604.
>
> Even though not very exact, I wished to write this to you, Most Excellent Sir, about the comet, in order to induce you to give a more exact account, which I look forward to from your kindness. The use of Tycho's instruments, which I hope were at hand, make for more accurate observation. I certainly wish for something accurate, and confirmed by your authority, in order that I may the better, and more easily convince those, who follow the opinion diametrically opposed to ours as regards the place of these comets in the universe, and who wish to have comets in the higher atmosphere, according to the mind of Aristotle, although, I believe, Aristotle himself, would not withhold assent to our clear evidence.

> Goodbye, Illustrious Sir, and in your kindness pardon my interrupting, to some extent, your most pleasing studies and worthy work. Given at Mainz, November 1, at 6 P.M., before which, scanning the clear western sky, I could not see a trace of anything, perhaps because the almost full moon interferes with its rays.

Kepler himself had seen the comet, intermittently (because of bad weather), from September 26 to October 26. His own observation of October 26 was the last he knew of it. As the earliest record of it he wrote, in the second part of his tract, "On the night of September 23, it was seen by a monk in Swabia," of this he had learned from Brengger. Having written of its appearance, and path across the sky, and disappearance, he had, at length, to come to its astrological signification. Kepler found in recent events sufficient reason for a comet to appear. The Empire had been at war with the Turks since 1593; in November, 1606, peace was concluded with the Porte at Zsitva-Torok. If this was not reason enough for a comet to appear, there was the struggle between Paul V and Venice, which terminated in April, 1607. The comet of 1531 had appeared after the failure of the Turkish attack on Vienna, and the fall of the Florentine Republic. Kepler was always careful. On November 24, 1607, he had finished what he had to say of the comet, and wrote to Herwart: "I have written a thing about the comet; I await the Emperor's orders with respect to it." What precisely the Emperor's orders were, we do not know; but we do know that Kepler translated his tract into Latin, and sent the German version to Leipzig to be printed. At Leipzig, his troubles began.

The university at Leipzig was founded when the university at Prague was becoming Hussite; Leipzig University was known as the German Prague. After the Reformation, Leipzig was strongly Lutheran. Even in Kepler's time, it was becoming the center of the book trade; but its books were severely censored. The printer to whom Kepler sent his booklet on the comet took the manuscript to Dr. Joachim Tanckius, professor of medicine at the university. Tanckius wrote to Kepler that

he had given the printer instructions to go ahead; but he would like to see Kepler's Latin work, of which mention was made in the German. Two weeks later he reported that the German version was ready; but, there was bad news.

> Our Aristotelians are unwilling to admit what you say about spirits. Wishing to show themselves wise, they show themselves most unwise. They swear by the words of their master and cry, *ad nauseam,* that comets are exhalations. They prefer to err with Aristotle, then to think with the more prudent. . . . I await your Latin work on the comet. . . .

Kepler would not send his Latin manuscript to Leipzig, unless he could get it printed there. Instead he wrote to the theologians of Leipzig, in Latin, what he thought of the origin of comets, sending the letter to Tanckius, who replied:

> Your letter to the theological college, I gave to the Dean, from whom you may expect a judgment soon. I spoke about the matter to the professor of physics, who did not hesitate to approve; but what you write about the spirit of comets disappearing after the comets expire made him a little uneasy. Our theologians do not admit the creation of new creatures after the first, nor their evanescence, I judge. . . .
>
> P.S. Since I wrote this, the Dean of theology himself, D. G. Weinrich, has come, and read to me your letter, of which he does not disapprove, except in the end of the first part, where you say that God creates the spirit of a comet, and the same afterwards evanesces.

The upshot of the squabble was that Kepler's book, printed at Leipzig, was published at Halle in Saxony. Kepler sent a copy to his friend Brengger, and asked him for a candid opinion. If Brengger had been a confederate of the theologians at Leipzig, he would not have replied differently. He wrote:

> I received your letter together with your tract on the comet of last year, on which you ask my opinion. But I, dear Kepler, would prefer first to read your Latin writing, which you promise. However, to oblige you, I submit a few points. . . . The last assertion of the first part of your German version, that God creates a new spirit or moving intelligence to direct a comet, which returns to nothing after it has performed its duty, although not put down as certain, will, I fear, be offensive to many, especially theologians.

With even Brengger finding his words not sound, Kepler saw the necessity of mending them. To Brengger he replied in April, 1608:

> You guessed right that theologians would be offended. They intervened to prevent my little book being published at Leipzig, because of that one paragraph about the creation of spirits. So I have changed it in the Latin. But my opinion is not too absurd. . . . I do not consider the spirit to be produced from nothing, but from the matter of the heavens.

The theologians asked merely that he use the word *creation* only when he meant "production from nothing"; the philosophers would have preferred the word *form,* instead of *spirit.* But it was now April, 1608, and no time for disputing about words. About the middle of the month, Matthias, as a tool of the leaders of the Calvinist party, advanced against Prague at the head of a considerable army, recruited from the Hungarian and Austrian Estates. War was in the air. When Matthias was only five miles from Prague, Rudolph ceded to him Hungary, Austria, and Moravia. The days were troubled; Kepler had neither taste nor time for correspondence. The difficulty of finding a printer to handle his Latin book on the comet was augmented, and besides, this Latin book had not predicted the new turn of events; neither had the German book. The Latin version, he now put away in his desk, and there it stayed for eleven years. At the end of the year 1608, returning to his correspondence, he acknowledged Father Ziegler's letter about the comet, and, in appreciation, sent a copy of his *Bericht vom Cometen des 1607. Jahrs.* But he tore out the pages which were offensive to the Lutheran theologians at Leipzig. In his last letter to Kepler, Father Ziegler asked Kepler would he please send an unmutilated copy of his *Bericht.* Kepler did not.

The comet of the year 1607 was the last comet seen before the invention of the telescope. In 1618 three comets were detected. Two of them might not have been recognized as comets but for the telescope; none of them were spectacular.

The first was detected in August, and the second in early November; the third, which remained in the sky until early in 1619, was first seen toward the end of November. It did not need a Kepler to tell the superstitious people that there was reason for a comet that year, indeed, for three. In May, there was the defenestration at Prague, in September the Thirty Years' War was under way in Bohemia, and in December the Empress died.

The defenestration at Prague was the spark which set off the Thirty Years' War. Kepler was, in a way, remotely responsible for it. In March 1617, he was summoned to Prague by the Emperor. Matthias was worried; the outlook was black; what had the stars to say? From March until the end of May he was retained at Prague. He cast, as he had done before, the Emperor's horoscope. He insisted, as he always did, that too much faith should not be placed in one's stars; but he admitted his belief that one's natal stars indicated tendencies. Matthias' future was not bright. Kepler approved, if he did not counsel, the Emperor's leaving Prague, and leaving the government to Regents. The Regents would be firmer than the Emperor in dealing with the Evangelical Union. They were; and for their unfaltering attitude two of them were thrown from the chancery window. It was the signal for revolt. The Bohemian Protestants set up a provisional government; most of the royal towns threw in their lot with the rebels; an army was raised to capture the towns which remained loyal, notably Budweis. By September two armies, of about 13,000 soldiers each, were facing each other in Bohemia; in November, Pilsen was captured by the rebels, and a comet was seen in the sky.

The Imperial Astronomer, of course, had to write of the comets. It was now a simple task; he had but to open his desk and take out the Latin manuscript, written in 1607 and never published, and add the little he knew of the comets of 1618. Very conveniently, before his work was finished, the Emperor died; Kepler had to make no apology for three comets, and he had a sizable book to publish. It came out with the title: *Three Books on Comets . . . I. Astronomical . . . II. Physical . . . III. Astrological.* The first book was on the observation of the comets of 1618; the second was the Latin translation of the first part of his German book of 1607; and the third was the Latin version of the second part of the German book, with a few additional remarks about the comets of 1618.

In the first book, Kepler had to confess that he had not seen the three comets himself, and reminded his readers that, being shortsighted, he had to rely on the observations of others. He relied on the observations of two Jesuits, the first is now an historical titbit, which he serves thus:

> On November 14/24, at Budweis in Bohemia, in the winter quarters of His Majesty's army the sky being clear, a comet was seen, with a bright head and tail, as I have been told by Maximilian Marsili, of the Society of Jesus, who was then there present.

Father Marsili never made his name in science, but his brother Cesare, a layman, did. In 1625 Cesare Marsili, of Bologna, wrote to Galileo to defend Kepler's supralunary theory of comets, and in 1626 was admitted as a member of the Accademia dei Lincei.

The second Jesuit observation which Kepler had, he did not receive directly, but through Herwart from Father Cysat at Ingolstadt. Father Scheiner had been replaced at Ingolstadt by Father Cysat, of whom Kepler had never heard, but of whom he was to hear immediately. Kepler's books on the comets were not only both astronomical and astrological, they were also a rehash and a hodgepodge, and they were vague on the comets of 1618. Father Cysat put out a book that was purely astronomical and precise; it dealt with the last comet of 1618; he entitled it: *The Mathematical Astronomy of the place, motion, magnitude, and causes of the Comet which shone in the sky at the end of the year 1618 and the beginning of the year 1619.* This book is now best known for its mention of the Orion nebula. A faint comet looks nebulous, like a fuzzy star, or one out of focus. Father Cysat explained that the comet he watched all through December, 1618, was in brightness not much different from the nebulosity in Orion. For many years,

indeed centuries, this was the earliest known reference to the great nebula in Orion; but wider reading, in the nineteenth century, brought to light a reference to it in 1611 by the French naturalist Nicholas Peiresc.

In the Roman College there were, in the department of mathematics, one professor and three assistant professors. It was left to one of the assistant professors to treat of the comets. About the same time that Father Cysat was getting out his book at Ingolstadt, Father Horatio Grassi published *About the three Comets of the year 1618. A Public Disputation held in the Roman College of the Society of Jesus by one of the Fathers of the Society.* In the month of August, 1618, he said, rumors circulated in Italy about a comet "between the feet of the Big Bear." Its existence was confirmed by letters from Germany, and it was detected in Italy, August 29, between two stars of the Big Bear. On November 18, a second comet was seen, below the Lion, near the constellations of the Cup (Crater). The third was the best, with a tail 40° long. Father Grassi observed it on November 24, and then wrote to Antwerp for their observations. Comparing the observations at Antwerp and Rome, he made out that the comet was not in our atmosphere, the height of which he set as 100 miles. With its distance estimated, and measurements of its diameter made at Rome and Cologne, he calculated its volume in the hundreds of thousands of millions.

Grassi used the answer as a proof that comets were not exhalations of the atmosphere; a comet would hardly fit in the atmosphere. That comets did not shine by their own light he attempted to show by the facts that their tails are always turned away from the sun, and that they move in orbits, not unlike the planets. He finished off with a detailed calculation of the distance of the last comet, which he made out to be 572,728 miles away, that is more than twice as far away as the moon. All this was gall and wormwood for Galileo, whose name Father Grassi never mentioned. Galileo's position was weakened by the fact that he had not observed the comet in question himself, for he was ill in bed. He deputed, however, one of his students

to defend a thesis asserting that comets were nearer to us than the moon, and did not move in orbits like the planets. The thesis was published at Florence as *Discorso delle Comete di Mario Guiducci, fatto da lui nell' Accademia Fiorentina.* The true author showed his hand in attempting to establish the sublunary nature of comets (against Grassi and Kepler), and their motion in straight lines (with Kepler against Grassi). With the anagrammatic pen name Lothario Sarsi Sigensavo, Father Horatio Grassi of Savona replied, in Latin, with his: *Astronomical and Philosophical Scale with which the opinions of Galileo about Comets, recently expounded and published by Mario Guiduccio, are examined.* The great service this book rendered to humanity was this: it drew forth from Galileo his *Il Saggiatore* which is rated by some who ought to know, as the best piece of Italian prose ever written. It came forth bearing, on the title page, the arms of Pope Urban VIII, to whom it was dedicated, with permission. Father Grassi, wisely, did not answer it; he left it to posterity to judge that he had the best of the astronomical argument, though he was no astronomer, and that Galileo had a literary triumph.

Galileo's *Il Saggiatore* was not written in a night; it appeared four years after Father Grassi's *Astronomical and Philosophical Scale,* had been published in Perugia. Meanwhile, Sciopone Chiaramonti, professor of philosophy at Perugia, could not let Father Grassi's *Scale* go unchallenged indefinitely; in 1621 he came forth with an impersonal answer, entitled: *Antitycho, in which against Tycho Brahe and some others . . . comets are shown to be sub-lunary and not celestial.* He may have thought that he would avoid controversy by attacking Tycho Brahe, who was in his grave; in fact, he made a way for Kepler to enter the lists. Chiaramonti was not only a professor, he was also a knight. After Kepler had read the knight's work and also Galileo's *Il Saggiatore,* he rushed into the fray, in the beginning of the year 1625, with *A Warrior Defending Tycho Brahe, the Dane, against Sciopone Chiaramonti's Antitycho.* In the body of the book, Kepler does not deal with Galileo's *Il Saggiatore,* but he has an appendix devoted to it. He begins the

appendix by protesting that he does not give a decision about the controversy between Galileo and Sarsi, because that controversy covers a larger field than his *Warrior* undertook to defend. The object of the appendix is to criticize references to himself made by the parties concerned in the controversy. Galileo accused Sarsi of "inclining toward the opinion of Kepler that comets could shine by reflection." "Galileo," says Kepler, "is not clear about my opinion; for twenty years I have taught that comets shine by reflection, not 'that they could,' but that they do." Father Grassi had written:

> Although Kepler had attempted, before Galileo, to explain the motion of comets by linear motion, he found that he got himself into difficulties. . . . In order to explain all the phenomena of comets, he had to suppose the earth moved, which is in nowise permitted to us Catholics to do.

Kepler noted this passage, and made a disclaimer. He was not the first to suggest rectilinear motion of comets; and there would be no end if one endeavored to find out who was. Secondly, he did not see any difficulty, granted the motion of the earth; "and you," he said to Sarsi, "do not see the difficulty, but fear it." And as for Catholics not being able to hold that the earth moved, he regretted the bitterness of the times that brought that about. "Copernicus," he wrote, "was certainly a Catholic, when he wrote to Paul III that *it was in no way forbidden.*" His own bitterness he cloaked in classical allusions.

> But let Perillus teach his ox to bellow. Unless I am greatly mistaken, he is afraid of Silenus' face, which silly Aegle has painted red.

Chiaramonti endeavored to refute Kepler in his *Apology for Antitycho*. Kepler did not reply to the *Apology*, and he could not understand the Jesuits at Rome taking up the cudgels on his behalf.

CHAPTER X

AIDS TO ASTRONOMY

In the years 1614 and 1615, Father Scheiner used to leave Ingolstadt for months at a time to go to Innsbruck "to solve mathematical problems for the Archduke Maximilian." During his absences, Father Johann Lanz of Munich would come to take his place. In 1616, Father Scheiner, at the request of the Archduke was transferred to Innsbruck; and Father Lanz, who was an older man than Father Scheiner, and who had been a successful teacher of arithmetic and geometry, found himself installed at Ingolstadt. In 1616 he published, at Munich, an arithmetic in four volumes; and in 1617, at Ingolstadt, the first six books of Euclid. These books were not of the stamp of Scheiner's works; and it was well for Ingolstadt that Father Lanz was only loaned to them.

In 1618 there was a young man ready to teach, and counted fit to take over at Ingolstadt, Father Johann Cysat. Father Cysat had been a pupil of Father Scheiner; and as is not unusual, the student was more modern than the mentor. His mind was not covered with cobwebbed theories hindering the absorption of the new. He was fortunate to have been greeted at Ingolstadt by a comet; it was something on which to work. He communicated the results of his observations to his predecessor, Father Lanz, at Munich. Father Lanz talked over the work at Ingolstadt with Herwart, who lived at Munich. Herwart passed the information on to Kepler. This indirect link to Ingolstadt was to prove useful to Kepler the year after Father Cysat put out his book on the comet, that is, in the year 1620.

In August, 1619, Ferdinand, King of Bohemia, was in Frankfurt for the election of an Emperor. On August 28, he himself was unanimously elected. Hardly had the result become known,

than news arrived that nine days before he had been deposed as King of Bohemia by a Diet of Protestants, held at Prague. As his successor Frederick V, Elector Palatine, had been chosen. On November 4, Frederick was crowned King of Bohemia at Prague. By Imperial Mandate, the Elector Palatine was given until June 1, 1620, to resign his usurped position, and quit the Emperor's dominions. Frederick did not resign, he armed. Ferdinand proceeded to encircle him. He empowered the Elector of Saxony to occupy the Lusatias and Silesia, and commissioned Maximilian, Duke of Bavaria, to occupy Upper Austria, in his name. Maximilian reached Linz on August 4, 1620, and set about subduing recalcitrant Austrian troops and exacting allegiance to the Emperor. It was evident, from the size of the armies, that there was going to be a big war the decisive battle of which might be fought between Linz and Prague. Already Linz was almost a military camp.

Kepler's troubles never came singly. At this juncture, he learned that his mother, who a few years before had been charged with witchcraft, was now thrown into jail in Güglingen. He wrote to the Duke of Württemberg on her behalf; but this was not enough; she had need of a powerful advocate at her side. He was torn between filial and conjugal devotion. He found a way to serve both. In September, he obtained leave of absence, and set forth for Württemberg, to go to his mother's assistance. He arranged for his wife and two little sons to follow to Ratisbon, "where they would be free from the dangers of war, and nearer to me," he wrote. He set out alone. At Ratisbon, he arranged for his family's arrival. Then he set out for Ingolstadt. He had a few things he wanted to publish; he could get no printing done in Linz. Herwart suggested that the Jesuits at Ingolstadt might take care of his unpublished *Ephemerides*. They told him that the approval of the Duke of Bavaria must be had. He asked Herwart to get the necessary permission, and send it to Ingolstadt, while he continued his journey. In October he was at Tübingen, discussing a new lunar theory with Mästlin. He was at his mother's side, far from the battle fields, when the Emperor's troops were routing

Frederick's at Weissenberg, west of Prague, and did not return to his family, at Ratisbon, until early in the year 1621. That he paid another visit to Ingolstadt, we know from a letter from Father Cysat to Kepler.

> Two days ago, immediately after you left for Ratisbon, the printer, Eder, gave me a letter, written on your behalf, to give to our Rector. It was from Herr Herwart about the *Ephemerides,* and was written last October. The gist of the letter was this: It seemed to him, to the other Counsellors of the Duke, and to the Rector of the College at Munich, that your *Ephemerides* could be published at Ingolstadt, since they contain nothing against the Catholic faith. Father Johann Lanz (in a letter written to me) says that the Rector of the college and himself think that the *Ephemerides* could be published at Ingolstadt, especially if the name of the place and printer are omitted. He added, furthermore, that he had heard from Herr Jocher, recently returned from His Grace, at Linz, that permission had been granted you to reside in Munich, for which reason your request should be more readily granted. Having read these two letters, the Rector and the Dean of Theology immediately granted the permission. Therefore, there is now nothing to prevent your *Ephemerides* being published at Ingolstadt.

After the receipt of this letter Kepler set out for Ingolstadt again, and there his *Ephemeris for 1619* and his *Ephemeris for 1620* were published; they were printed without the name of place of publication. The one for 1620 is noteworthy for its dedicatory letter addressed to John Napier of Scotland, the inventor of logarithms. This letter is dated July 28, 1619. Kepler did not know that Napier died in 1617. In his letter, Kepler congratulates Napier on his invention, and on the benefit he has conferred on astronomy in general, and himself in particular – for he had been saved much work, in the preparation of his *Ephemeris,* by use of logarithms. Napier announced his discovery in his *Description of the Wonderful Canon of Logarithms,* published in Edinburgh in 1614. Kepler states that he saw this book at Prague in 1617 (when he was called to Prague by the Emperor Matthias), and that he had not the opportunity to study it. In 1618, he met with a little book by Benjamin

Ursinus, which gave a description of it, and reprinted Napier's table of logarithms. Napier's table gave the logarithm of sines of angles to seven decimal places; Ursinus omitted the last two figures of every logarithm. When we know how Napier got his idea, it is not surprising that he worked out the logarithms of trigonometric functions before the logarithms of numbers.

In 1582, Tycho Brahe had as assistant Wittich of Breslau. Wittich was not unlike other assistants with tedious work to do; he endeavored to find short cuts. The best laborsaving device he discovered was practically a formula well known to all college freshmen today, namely, that twice the product of two sines is equal to the cosine of their difference minus the cosine of their sum. This formula enabled him to substitute simple subtraction for lengthy multiplication; he discovered it when working on a spherical triangle, and called his method of calculation prosthaphaeresis. In 1584, Wittich made his method known at Cassel, and Jost Bürgi proved it to hold for the product of any two sines. Father Clavius generalized the method in his treatise *On the Astrolabe,* published in 1593. Father Clavius made the following enunciation, as a lemma: "All questions, which are usually solved by sines, tangents, and secants, can be solved by prosthaphaeresis alone, that is, by simple addition and subtraction, without laborious multiplication and division of numbers." Before proceeding to the exposition of his lemma, he introduced the question as follows:

> Three or four years ago Nicholas Reymer Ursus published a little book in which, besides other things, he explains the sagacious and ingenious discovery by which many spherical triangles can be solved by prosthaphaeresis alone. But since he thinks that this can be done only when the sines are of regular proportion and in the first quadrant, we shall try to make the doctrine more general, so that it can be used not only for sines, and when the sine is in the first quadrant and of regular proportion, but also for tangents, secants, versed sines, and other functions, regardless of their values or proportions, which is something entirely new, and most enjoyable and delightful.

Kepler tells us that "a Scotchman in the year 1594, in a letter

to Tycho, gave some hope of *The Wonderful Canon of Logarithms.*" This Scot is believed to have been Dr. John Craig, a friend and correspondent of Tycho Brahe, and a friend of Napier. Thus Wittich's prosthaphaeresis led to Napier's logarithms; and, it would seem, that Napier was working twenty years on his *Wonderful Canon,* before he published it.

After arranging for the printing of his *Ephemerides* at Ingolstadt Kepler proceeded to Munich to see his friend Herwart, and to talk chronology. From there he went to Ulm, to have some more printing done; and then to Tübingen, where he discussed logarithms with Mästlin, who was not enthusiastic. When he arrived in Güglingen, he found that his mother's trial was postponed. He went on to Frankfurt to have more printing done. It was August, 1621, before the trial in Güglingen got under way, and September before Kepler's endeavors, eloquence, and influence obtained an acquittal. He was not back in Ratisbon until November. Then he left his family to return to Linz, and learn how things stood there, and, above all, whether any salary was awaiting him. During his fourteen months' absence Kepler was not, presumably, supporting himself and his wife and family on fresh air. The only one to whom we find him making acknowledgment of pecuniary aid is the Jesuit Father Paul Guldin. Nearly all things good that came Kepler's way at this time, he attributed to Father Paul, with whom he first started corresponding in 1618. Father Guldin is one Jesuit who could be said to have been a friend of Kepler. Their friendship was founded on mutual appreciation. Of Kepler's mathematical works, Father Guldin was the most appreciative of all Kepler's friends.

Father Guldin was a Swiss by birth. He was born of Protestant parents, who christened him Habakkuk. While practising his father's trade of goldsmith, he was converted to Catholicism. Not long after his conversion he joined the Jesuits as a lay brother. For twelve years he rendered valuable assistance to the Fathers in that capacity. When it came to designing and building churches, he displayed a phenomenal knowledge of mathematics. He would, it was thought, make a good professor.

But lay brothers did not teach, so he was sent to Rome to study for the priesthood. He studied for eight years, doing philosophy, theology, and mathematics. From 1609 to 1612, he had Father Clavius to guide him in mathematics. In 1617 he was appointed to the chair of mathematics in Graz. One of the first books he devoured on coming to Graz was Kepler's *New Stereometry of Wine Barrels.*

Stereometry is the measurement of solid capacity. Kepler became interested in the subject when he went marketing with his wife. He watched a man gauging the contents of a barrel, and remarked that the method was not mathematically accurate. But nobody had ever worried much about the mathematics of a wine barrel. Kepler went back to his Archimedes. Archimedes had considered the volumes of solids generated by rotating circles and conic sections (ellipses, parabolas, and hyperbolas) about their principal axes. Kepler considered the solids formed by rotating conics about lines other than their principal axes; he found he had a fine variety of shapes and figures. To calculate their volume he considered them cut into slices, and their volume to be the sum of the volume of their slices. Thus, if a lemon were put through a bread-slicing machine, end on, and cut into circular slices, its volume would be the sum of the volume of the slices. There would remain the problem of finding the volume of the slices. Kepler's speedy method of doing this was not quite correct, as Father Guldin pointed out. Kepler had not the notion of an infinitesimal (a variable whose limit, never reached, is zero), but he sowed the seed of the notion. Indeed, his *Stereometry* was a thought-provoking book.

In endeavoring to improve upon this work, Father Guldin propounded two theorems, which were known as Guldin's theorems for two centuries, but are now known as the theorems of Pappus. Pappus of Alexandria propounded them at least thirteen hundred years before Father Guldin. The Guldin-Pappus' theorems say that if any plane curve revolves about any external axis in its plane, then: (1) the surface of the solid which is thereby generated is equal to the product of the perimeter of the revolving curve and the length of the path described by the center of gravity of that perimeter; (2) the volume of the solid is equal to the product of the area of the revolving curve and the length of the path described by the center of gravity of the revolving area.

It can be readily understood that Father Guldin was a mathematician after Kepler's own heart. He showed his devotion to Kepler's studies in another way also. When Kepler was exiled from Linz, and cut off from Prague, Father Guldin was concerned not only about his financial predicament, but also about his inability to scan the skies; for Kepler had no instruments of his own, which he could carry with him. When he came by a telescope, it reached him by a devious route. Alessandro Cardinal Orsini arrived from Rome as legate to the Emperor, Ferdinand II. With him arrived Father Nicholas Zucchi, an Italian Jesuit. Father Zucchi had some name as a telescope maker, and had brought a telescope with him. To Kepler he gave this telescope. Like a boy with a new toy, Kepler wrote to Father Guldin that he had received this telescope, all for himself, not a loan, and no strings attached. Kepler added that he suspected he was indebted to Father Guldin for its coming.

Father Zucchi also presented Kepler with a copy of Chiaramonti's *Antitycho.* It was a copy which Chiaramonti had presented to Cardinal Orsini. It served Kepler to write his defense of Tycho's theory of the place of comets; he wrote it with verve. But when Kepler heard of Chiaramonti's *Apology,* his enthusiasm was gone; for he heard also that the Jesuits in Italy were fighting his cause, and he had no desire to be their comrade in arms. It was the year 1626, and he was thinking much about the Catholic Church, and the more he thought about it, the less he liked it. He was thinking much because the great astronomical tables, which he had commenced under Rudolph II, were nearly completed. At their completion he would have to surrender his position or become a Catholic; he had been retained by Ferdinand II only until they were completed.

The choice which Kepler would soon have to make, his co-religionists in Upper Austria had already to make. Easter, 1626, had been set as the date for the adoption of Catholicism by the

population, with the alternative of emigration. It was the peasants who most resented the decree; they rose in arms. On June 24, Kepler tells us, Linz was besieged by insurgent peasants. From then until August 29 there were many assaults on the city; and there were "bombardments, fire, and dysentery." "But, by the help of God, and the guardianship of His angels," wrote Kepler, "I came through unscathed; nor was I hungry, though I eat no horseflesh." Astronomical work was much impeded. But Kepler was not idle. What he thought he put on paper. He wrote a theological tract, attempting to prove that the Catholic Church was not Apostolic, in the sense of being the Church founded by Christ. He hoped to publish what he wrote, but later thanked his stars that he had not done so. Probably he put it in the fire. No trace of it has ever been found, but there are references to it in his letters. He sent it to Professor Christopher Besold, at Tübingen. Besold counted Kepler an inept champion of Lutheranism, for Kepler, since 1612, had been barred from receiving Communion in Lutheran Churches, because he denied the permanent presence in the Eucharist. Besold wrote:

> I return the draft of the theological tract, which you are preparing against the Roman Catholics. It pleases me because of its candor, and the absence of the tricks of the controversialists who defend our doctrine. And you accommodate yourself to the understanding of those not versed in the subtleties of modern theology. I would like to see it published, but would not like to see your name prefixed to it; not, of course, because of you, but because of the matter, which would not be altogether pleasing to ours, and would seem ridiculous to our adversaries, since you fight for those who refuse you the sacraments, and do all but proclaim you a heretic.

When Kepler received this letter from Besold he was more concerned with deeds than words with which to counter the Counter Reformation. An order had been promulgated in Linz that all youths must attend Catholic universities. Kepler arranged that some friends should kidnap his son Ludwig (aged 19) and send him to a Lutheran university. They did; and sent him, first, to Sulzbach. Kepler professed, with truth on his side,

that he did not know where he was. Later he was to learn that he had obtained, through the intercession of the Duke of Württemberg, a scholarship at the University of Tübingen. Kepler learned this after he himself had shaken the dust of Linz from off his feet. He left Linz in good standing. With the *Rudolphine Tables* finished, he obtained permission to go to Ulm to have them printed there. In November, 1626, he set out with his wife and children and belongings for Ratisbon. There he left the family and went to Ulm. He wrote to Father Guldin to tell him of his movements. He also told him that the time was coming when he must make a choice between permanent exile from Austria and Catholicism. And he told Father Guldin why he could not see his way, at present, to choose Catholicism.

He told his friend, in plain, unvarnished terms, what he thought of the Catholic Church. His main argument was this; the Catholic Church had sowed mustard in the field of Apostolic teaching. Scripture and Scripture alone was Kepler's guide — and he needed no guide to tell him how to interpret it. Father Guldin accepted the letter as a challenge; he was a convert, and should defend his choice. He attempted to persuade Kepler that the Catholic Church was indeed the Church of Christ. Christ had never told the Apostles to write; He told them to teach and to preach. What they wrote was true, but not all the truth; the Apostolic teaching was passed on by word of mouth in early days. One year passed before Kepler replied to Father Guldin; when he did write again, it was from Prague, where he had gone to report to the Emperor that he had finished the work which the Emperor had given him to do. Meanwhile he had corresponded with, and spoken to, another Jesuit friend, Father Curtz.

Father Albert Curtz was a very young man. He was born in Munich in the year 1600, the year in which Kepler joined Tycho Brahe at Prague. He was only twenty-four years of age when Kepler learned from him a lunar theory "born of beautiful genius." When Kepler commenced the printing of his *Rudolphine Tables* at Ulm in May, 1627, he wrote to Father

Curtz, at Dillingen, for advice as to their form; and until the tables were finished, they kept up their correspondence on details. But they wrote also, of many other things, and not the least was of Kepler's faith. Kepler broached the subject in his first letter, and only in the fourth of six (written in five months), did Father Curtz remark "the absence of friendly controversy." Father Curtz was mild, but firm; he pointed out that if Kepler saw fit to air his difficulties, it was because he had doubts; if he had doubts; it was because his conscience troubled him. Even if I should keep quiet, he said, the voice of Scripture, Tradition, the Fathers, and God Himself would be heard. For that reason he did not place too much stock in his own words. He directed Kepler more than he argued with him. He knew, as did Ambrose, that it is not by dialectics that the world is saved. As parts of the *Rudolphine Tables* came off the press, Kepler kept sending them to Father Curtz, so that, at the end, Father Curtz had, for himself, a complete set, with Kepler's compliments. But they had still much to say. Kepler had on hand a criticism of Scaliger's treatise on the procession of the equinoxes, which Father Curtz was ready to see through the press when it was completed. Moreover, Father Curtz had sent to Kepler a letter of a Jesuit from China on the reformation of the Chinese calendar, which Kepler would like to discuss at length. So it was agreed that Kepler should stop at Dillingen on his way back to Ratisbon. In his last letter addressed to Kepler at Ulm, Father Curtz wrote:

> In other things I admire you, in other things I praise you, but in the matter of your salvation, I pray you not to trust so much to your own genius, as though you alone, without a guide could hope to find the truth; and I pray you to fear lest you lose your way in the maze and glare of so many and so great stars.

On leaving Ulm, Kepler had to go far and wide to distribute his tables. For three months he was little more than a salesman. The tables had been printed by Imperial order; the Imperial towns had to contribute to the cost of their printing. The profits from their sale were to be divided equally between Kepler and

Brahe's heirs. From Ulm Kepler went to Heidelberg, Frankfurt, Puzbach, back to Frankfurt, on to Mainz, Worms, Speier, into Belgium, to Brussels, then to Esslingen, and back to Ulm. From Ulm, this time, he went to Dillingen, and remained three days, the guest of Father Sigersreitter, the Rector of the Jesuit College. He told Father Curtz he had not finished his work on Scaliger's treatise; they must wait. He discussed the letter from China, which he found very interesting. He would like to publish a commentary on it, and that was agreed. He took a copy of it with him. He disposed of three copies of his tables, one for the College, one for the Bishop, and one for Ingolstadt College.

The author of the letter from China signed himself, in Latin, *Joannes Terrentius*. He was born in Switzerland, and his father's name was Schreck. As a physician and mathematician, Johann Schreck had made a name for himself before he entered the Jesuits, at the age of thirty-five. He had the distinction of being ejected from Accademia dei Lincei. The rules of the academy barred Religious from being elected members. Schreck's case became a test case; it was decided that a member could not become a Religious without forfeiting his membership. Kepler had heard of Schreck before.

In 1618 Remus wrote to Kepler that he had heard from Father Schreck that when Venus was observed in conjunction with the moon on June 6, 1617, it was further from the moon than Kepler predicted. "This observation," Father Schreck wrote from Lisbon, "was made by Father Lembo, who is now in Naples, and by Father Pantaleon, who is sailing with me to China." Father Pantaleon's full name was Wencelas Pantaleon Kirwitzer; in his signature, he omitted his surname. He, too, was a bit of a thorn in Kepler's side. He wrote to Father Ziegler (who was European Procurator for the Chinese Mission), from Goa, in February, 1619, saying that he had seen a comet in India, and, going back a hundred years, telling of an eclipse seen in Cochin on January 13, 1507. It was this eclipse which bothered Kepler. He was not sure of the fact. Father Kirwitzer's authority was Joao de Barros' *History of the Portuguese in India*. Kepler had not heard of de Barros or his history. In his

Rudolphine Tables, he harped back on the possibility of the eclipse reported by Father Kirwitzer.

From Dilingen Kepler went to Ratisbon. Among the first things he did at Ratisbon was to write his commentary on Father Schreck's letter from China. The all-important business to which he had to attend was to arrange to see the Emperor. He set out for Prague in December, 1627, and stayed there until the following April. To Prague came also the great general, Wallenstein, Duke of Friedland, fresh from his conquest of Schleswig and Jutland. In September, 1627, he had been given the Silesian principality of Sagan; now he had come for further reward, which he obtained, in the form of the territories of the Dukes of Mecklenburg. In the halls of the Imperial Palace he met Kepler, Kepler who cast horoscopes. Wallenstein would like to have him as his private astrologer. The two men talked, and Kepler's future was brighter than he could have dreamed. Wallenstein would give him a home at Sagan, yes, and a library and a printing press, and he would ask the Emperor to permit Kepler to take Brahe's manuscripts there, and there he could prepare Brahe's observations for publication; the Emperor would be tempted to let Kepler go, because he was not a Catholic, and because Wallenstein would take upon himself the debt of nearly 12,000 florins which the Imperial treasury owed to Kepler for back salary. The Emperor readily agreed. And Kepler went to Sagan.

Kepler went to Sagan in July, 1628. He was hardly there when Wallenstein asked the Jesuits to come to Sagan. They came, two Fathers, in February, 1629, and one of them was Father Guldin.

CHAPTER XI

THE LAST CHAPTER

After two years at Sagan, Kepler had made no move toward publishing Brahe's observations. For thirty years they had been a gold mine to him. He had pleaded that he must first publish the *Rudolphine Tables.* Three years had passed since the publication of the tables, and there was as yet no sign or promise of their source, Brahe's observations. In January, 1630, Kepler published, from his own press at Sagan *A Letter from China of Rev. Fr. Johann Terrentius of the Society of Jesus, with a Little Commentary by Johann Kepler.* In his introduction, Kepler stated where he got the letter, and that he had written his commentary at Ratisbon in December, 1627. In an appendix, he had a note about the eclipse coming on June 10, 1630. In July he put out his *Ephemerides* for the year 1629 to 1635, and in September, his long delayed *Ephemerides* for the years 1621 to 1627. He wrote the dedicatory letter to these last on September 13, that is on the very day that Wallenstein's dismissal was officially announced. Wallenstein was relieved of his command of the army. It was the Emperor's order, approved by the Diet at Ratisbon. Now, where did Kepler stand? Who would pay him 12,000 florins? He must see the Emperor. He took his horse and rode for Leipzig. There he enjoyed the hospitality of Dr. Philip Muller, while he made inquiries. Yes; the Diet was still in session; he could see the Emperor at Ratisbon. He rode for Ratisbon through sleet and rain. He arrived in time; but he arrived with the beginnings of pneumonia. He never saw the Emperor. But the Emperor "was very sympathetic" when he heard he was ill, and sent him thirty florins to help him in his convalescence. There was no convalescence. He died. He died attended by a Lutheran minister. The chronicler of his end re-

counts that "in almost his last moment he was asked, by what means he hoped to be saved," and he replied confidently: "Solely by the merits of Jesus Christ, Our Saviour." The word *solely* was taken as evidence of his faith in the undiluted doctrine of Luther.

At Sagan, Kepler left a manuscript ready for the press. It was published by his son, Ludwig, with the title: *The Dream of Johann Kepler, the Late Imperial Mathematician, or a Posthumous Work on Lunar Astronomy.* It had an appendix, entitled by Kepler himself: "A Geographic, or, if you prefer, Selenographic, Appendix, to the Very Reverend Fr. Paul Guldin, Priest of the Society of Jesus, etc." The appendix was nothing else but Kepler's letter written to Father Guldin after he had studied the moon with Father Zucchi's telescope, with footnotes added.

Besides *The Dream,* Kepler left many other manuscripts. Most of them works begun; some, works to be published "some day." There was, of course, the commentary on Scaliger's treatise on the equinoxes, about which he had written to Father Curtz in 1627. And there were sheets with the title *De Initio Temporis,* which bore the beginnings of a dissertation on the *Annals of History* by Father Jacques Salian, S.J. Then, there were most copious notes on the *Opus De Doctrina Temporum* of Father Denis Petau (Petavius), S.J.

Brahe's manuscripts had been handed over to Kepler, with the understanding that he was to publish what he thought worthy. He published little; he promised that when the *Rudolphine Tables* were finished, he would publish more. What he left behind him, when he died in 1630, was published in 1666, by Father Curtz, under the assumed name of Lucius Barrettus (which is an anagram for Albertus Curtius). In the preface to his publication Father Curtz wrote:

> These certainly could have been published sixty years ago. But the fortune of books is often linked to the troubles of the times, and there was found a most wonderful excuse for publishing, before all else, the Rudolphine Tables, which were compiled from these observations. When the Tables were finally published in 1627, Lucius Barrettus, whom Kepler visited on his return from Ulm, argued, in a friendly way with his guest that there was no reason why Brahe's observations should be any longer denied to learned men, to whom Brahe had promised them. After many quibblings, he was to hear that these manuscripts were being retained by Kepler as a pledge of salary owed to him by the Emperor. But two years later death took Kepler, and not long afterwards, a sudden storm from the north spread over all Germany, which left nobody free to think of the stars. Even then, however, the providence of Ferdinand III was watching; and when he understood in what quarter these commentaries, which the Emperor Rudolph had purchased at so high a price from Tycho, were being awaited, he did not fail, even amid wars, to hand over the care of the matter to his Excellency George Martinitz, Chief Chancellor of the Kingdom of Bohemia, whose great care and singular industry has brought these books from hiding.

Thus, thirty-six years after Kepler's death, there was still engraved on Curtz's memory the thought that "these manuscripts were being retained by Kepler as a pledge of salary owed to him by the Emperor. But two years later death took Kepler." It would seem that if Kepler's life was marred, it was by too much thought of his earthly future. He was ever thinking of the morrow, providing for the morrow. He had not convinced himself that any time he might hear God say: "this night do they require thy soul of thee." His thoughts were of his barns. He feared the fate of all things that were grown to him; he feared it as did the servant of the merchant of Bagdad — that servant who saw Death in the market square, and thought she made a threatening gesture toward him. He rode, posthaste, to Samarra. Death had not made a threatening gesture, but started in surprise to see in Bagdad a man with whom she had a tryst that night in Samarra. With Wallenstein dismissed, Kepler saw Fate, and rode with sickening speed to Ratisbon — where Fate awaited him.

But, if the great astronomer was ensnared by the world around him, he did not forget that "we are born of nothing, and after this we shall be as if we had not been." For his tombstone, Kepler left written, in his own hand, his epitaph:

Mensus eram coelos, nunc terrae metior umbras:
Mens coelestis erat, corporis umbra jacet.

This might be freely rendered:

Within the narrow grave I now am pent,
Who scanned the vast pavilion of the skies.
Though spiritless in death my body lies,
My mind on heavenly things was once intent.

BIBLIOGRAPHY

Angus, W. Kenneth, "An Early Reference to an Astronomical Event," *The Journal of the Royal Astronomical Society of Canada* (1941), pp. 271–272.

Annales Ecclesiastici, auctore Caesare Baronio sorano congregationis Oratorii Presbytero (Rome, 1588–1607), 12 vols.

"Autograph Letter of John Deckers, S.J., to Blessed Robert Southwell, S.J.," Leo Hicks, S.J., editor. *Archivum Historicum Societatis Iesu,* 1 (1932), II, pp. 276–281.

Catalogi Provinciae Austriae S. I., 1599–1615 (In Archives S. J.).

Christophori Clavii Bambergensis e Societate Iesu, Astrolabium (Rome, 1593).

Duhr, Bernard, S.J., *Geschichte der Jesuiten in den Ländern deutscher Zunge,* 4 vols. (I and II, Freiburg, 1907–1913; III and IV, Munich and Regensburg, 1921–1928.)

Foley, Henry, S.J., *Records of the English Province of the Society of Jesus* (London, 1877–1880), 6 vols.

Joannis Kepleri, Astronomi Opera Omnia, Dr. Ch. Frisch, editor (Frankfurt, 1858–1871), 8 vols.

Le Bachelet, R. P. Xavier-Marie, S.J., *Auctarium Bellarminianum. Supplément aux Oeuvres du Cardinal Bellarmin* (Paris, 1913).

Le Opere di Galileo Galilei, Antonio Favaro, editor (Florence, 1890–1909), 20 vols.

Looten, Chanoine C., "Notes sur le R. P. Jean Deckers et son ami le martyr R. Southwell, S.J.," *Bulletin du Comite flamand de France* (1936), pp. 485–491.

O'Connell, D. J., S.J., "Easter Cycles in the Early Irish Church," *The Journal of the Royal Society of Antiquaries of Ireland* (1936), pp. 67–106.

Power, E., S.J., "John ii. 20 and the Date of the Crucifixion," *Biblica* (Rome, 1928), pp. 258–277.

Sommervogel, Carolus, *Bibliothèque de la Compagnie de Jésus* (Paris, 1890–1909), 10 vols.

Tychonis Brahe Opera Omnia, Dreyer, J. L. E., editor (Copenhagen, 1913–1929), 15 vols. in 17.

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Bruce